



PREFACE

WARNING

Electric discharge

The EXA analyzer contains devices that can be damaged by electrostatic discharge. When servicing this equipment, please observe proper procedures to prevent such damage. Replacement components should be shipped in conductive packaging. Repair work should be done at grounded workstations using grounded soldering irons and wrist straps to avoid electrostatic discharge.

Installation and wiring

The EXA analyzer should only be used with equipment that meets the relevant IEC, American or Canadian standards. Yokogawa accepts no responsibility for the misuse of this unit.

CAUTION

The Instrument is packed carefully with shock absorbing materials, nevertheless, the instrument may be damaged or broken if subjected to strong shock, such as if the instrument is dropped. Handle with care.

Although the instrument has a weatherproof construction, the transmitter can be harmed if it becomes submerged in water or becomes excessively wet.

Do not use an abrasive or solvent in cleaning the instrument.

Notice

- This manual should be passed on to the end user.
- The contents of this manual are subject to change without prior notice.
- The contents of this manual shall not be reproduced or copied, in part or in whole, without permission.
- This manual explains the functions contained in this product, but does not warrant that they are suitable the particular purpose of the user.
- Every effort has been made to ensure accuracy in the preparation of this manual.
However, when you realize mistaken expressions or omissions, please contact the nearest Yokogawa Electric representative or sales office.
- This manual does not cover the special specifications. This manual may be left unchanged on any change of specification, construction or parts when the change does not affect the functions or performance of the product.
- If the product is not used in a manner specified in this manual, the safety of this product may be impaired.

Yokogawa is not responsible for damage to the instrument, poor performance of the instrument or losses resulting from such, if the problems are caused by:

- Improper operation by the user.
- Use of the instrument in improper applications
- Use of the instrument in an improper environment or improper utility program
- Repair or modification of the related instrument by an engineer not authorized by Yokogawa.

Safety and Modification Precautions

- Follow the safety precautions in this manual when using the product to ensure protection and safety of the human body, the product and the system containing the product.

The following safety symbols are used on the product as well as in this manual.

DANGER

This symbol indicates that an operator must follow the instructions laid out in this manual in order to avoid the risks, for the human body, of injury, electric shock, or fatalities. The manual describes what special care the operator must take to avoid such risks.

WARNING

This symbol indicates that the operator must refer to the instructions in this manual in order to prevent the instrument (hardware) or software from being damaged, or a system failure from occurring.

CAUTION

This symbol gives information essential for understanding the operations and functions.



This symbol indicates Protective Ground Terminal



This symbol indicates Function Ground Terminal (Do not use this terminal as the protective ground terminal.)



This symbol indicates Alternating current.



This symbol indicates Direct current.

Warranty and service

Yokogawa products and parts are guaranteed free from defects in workmanship and material under normal use and service for a period of (typically) 12 months from the date of shipment from the manufacturer. Individual sales organizations can deviate from the typical warranty period, and the conditions of sale relating to the original purchase order should be consulted. Damage caused by wear and tear, inadequate maintenance, corrosion, or by the effects of chemical processes are excluded from this warranty coverage.

In the event of warranty claim, the defective goods should be sent (freight paid) to the service department of the relevant sales organization for repair or replacement (at Yokogawa discretion). The following information must be included in the letter accompanying the returned goods:

- Part number, model code and serial number
- Original purchase order and date
- Length of time in service and a description of the process
- Description of the fault, and the circumstances of failure
- Process/environmental conditions that may be related to the installation failure of the device
- A statement whether warranty or non-warranty service is requested
- Complete shipping and billing instructions for return of material, plus the name and phone number of a contact person who can be reached for further information.

Returned goods that have been in contact with process fluids must be decontaminated/disinfected before shipment. Goods should carry a certificate to this effect, for the health and safety of our employees. Material safety data sheets should also be included for all components of the processes to which the equipment has been exposed.

How to dispose the batteries:

This is an explanation about the new EU Battery Directive (DIRECTIVE 2006/66/EC). This directive is only valid in the EU. Batteries are included in this product. Batteries incorporated into this product cannot be removed by yourself. Dispose them together with this product. When you dispose this product in the EU, contact your local Yokogawa Europe B.V. office. Do not dispose them as domestic household waste. Battery type: silver oxide battery

Notice:

The symbol (see above) means they shall be sorted out and collected as ordained in ANNEX II in DIRECTIVE 2006/66/EC.



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1. INTRODUCTION AND GENERAL DESCRIPTION

The Yokogawa EXA is a 4-wire converter designed for industrial process monitoring, measurement and control applications. This instruction manual contains the information needed to install, set up, operate and maintain the unit correctly. This manual also includes a basic troubleshooting guide to answer typical user questions.

Yokogawa can not be responsible for the performance of the EXA analyzer if these instructions are not followed.

1-1. Instrument Check

Upon delivery, unpack the instrument carefully and inspect it to ensure that it was not damaged during shipment. If damage is found, retain the original packing materials (including the outer box) and then immediately notify the carrier and the relevant Yokogawa sales office.

Make sure the model number on the textplate affixed to the top of the display board of the instrument agrees with your order.



WARNING

The textplate will also contain the serial number and power supply selection. Be sure to apply correct power to the unit.

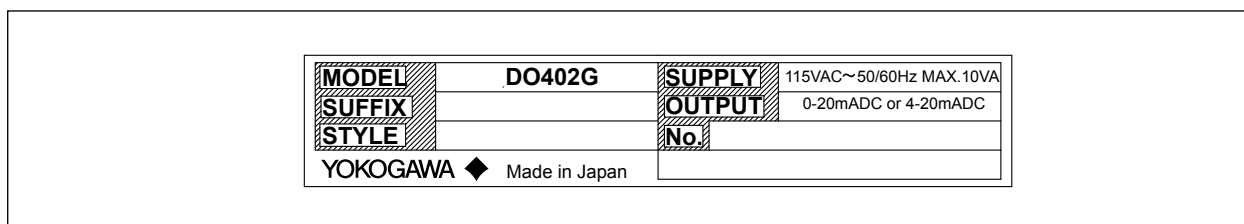


Figure 1-1. Nameplate example

Check that all the parts are present, including mounting bracket, as specified in the option codes at the end of the model number. For a description of the model codes, refer to Chapter 2 of this manual under General Specifications.

Basic Parts List: Converter EXA 402

User's Manual (See model code for language)

Optional mounting bracket when specified (See model code)

1-2. Application

The EXA converter is intended to be used for continuous on-line measurement in industrial installations. The unit combines simple operation and microprocessor-based performance with advanced self-diagnostics and enhanced communications capability to meet the most advanced requirements. The measurement can be used as part of an automated process control system. It can also be used to indicate dangerous limits of a process, to monitor product quality, or to function as a simple controller for a dosing/neutralization system.

Yokogawa designed the EXA analyzer to withstand harsh environments. The converter may be installed either indoors or outside because the IP65 (NEMA 4X) housing and cabling glands ensure the unit is adequately protected. The flexible polycarbonate window on the front door of the EXA allows pushbutton access to the keypad, thus preserving the water and dust protection of the unit even during routine maintenance operations.

A variety of EXA hardware is optionally available to allow wall, pipe, or panel mounting. Selecting a proper installation site will permit ease of operation. Sensors should normally be mounted close to the converter in order to ensure easy calibration and peak performance. If the unit must be mounted remotely from the sensors, WF10 extension cable can be used up to a maximum of 50 metres (150 feet) with a BA10 junction box.

The EXA is delivered with a general purpose default setting for programmable items. (Default settings are listed in Chapter 5 and again in Chapter 10). While this initial configuration allows easy start-up, the configuration should be adjusted to suit each particular application. An example of an adjustable item is the type of temperature sensor used. The EXA can be adjusted for any one of four different types of temperature sensors.

To record such configuration adjustments, write changes in the space provided in Chapter 10 of this manual. Because the EXA is suitable for use as a monitor, a controller or an alarm instrument, program configuration possibilities are numerous.

Details provided in this user's manual are sufficient to operate the EXA with all Yokogawa sensor systems and a wide range of third-party commercially available probes. For best results, read this manual in conjunction with the corresponding sensor user's manual.

1-3. General information

Flexibility, reliability and low maintenance are among the benefits provided by the EXA DO402G dissolved oxygen analyzer. Designed to meet the exacting requirements of measuring dissolved oxygen in the modern industrial environment, it contains many features to ensure the best precision whatever the application.

This 4-wire converter is housed in a robust IP65 field mountable case. Two mA outputs, four relays, digital communication and a clear LCD make the DO402G a truly comprehensive package.

The DO402G features PI control on both the auxiliary mA output and the pulse proportional relay outputs, thus avoiding the need for a separate controller.

The famous EXA sensor diagnostics are now expanded with a logbook facility in combination with the RS485 two wire communication software option. This can be used to record events like calibration and diagnostic messages, and to update configuration of the converter remotely.

The DO402G accepts inputs from galvanic, polarographic and optical sensors. Percent saturation, mg oxygen/l water, and ppm DO can be displayed and transmitted. Compensation for atmospheric pressure altitude, salinity and temperature are included for the best accuracy of measurement.

Features

- Simple 3 level operation
- Display mg/l, ppm, % saturation
- Air calibration or saturated water calibration
- Chloride concentration compensation can be programmed
- Automatic temperature compensation
- Built-in barometric air pressure compensation
- "Hold" function enables fixed output signal during maintenance
- Two separate mA output signals
- Wide flexibility incorporating free programmable range settings, selection of output signals and alarm functions
- Analog output with adjustable damping time
- Password protection for each programming level
- Built-in wash timer with remote start possibility
- IP65 weather protection
- Universal mounting possibilities
- Sensor diagnostics
- RS 485 bi-directional communication
- Logbook via RS 485 link
- PI control on mA and pulsed contact controls

Method of operation

The EXA DO30 operates on a galvanic cell principle.

The sensor contains a measuring cell consisting of a silver cathode and a lead anode. The voltage generated by this electrode pair is sufficient to generate a spontaneous reduction of oxygen at the cathode, so no external voltage source for this reaction is required. The electrodes are immersed in an electrolyte containing potassium hydroxide. Oxygen molecules can pass through a permeable membrane into the cell. The output current of the cell is directly related to the partial pressure of oxygen at the sample side. In the sensor a thermistor is integrated to be able to correct for temperature changes. Both signals are used in the converter to ensure an automatically compensated value for dissolved oxygen. Calibration is worked out by simple air calibration to make sure that the performance of the instrument will be maintained.

The DO70G sensor operates based on the principle of optical (fluorescence) measurement.

The sensor comprises a fluorescent membrane, light-emitting part, light-receiving part, and internal circuit. An external power source is required. Oxygen molecules pass through the permeable membrane to a fluorescent substance and shift the phase of fluorescent emission. The degree of this shift is inversely proportional to the partial pressure of oxygen on the sample side, resulting in the output of a current equivalent to the polarographic current adjusted by the internal circuit.

A temperature sensor is integrated in both sensors, and the temperature signals are used to automatically compensate the measurements of dissolved oxygen.

The combination of air-saturated water calibration and zero calibration helps maintain the performance of the instrument.

Display functions and ranges

The display continuously gives you all necessary information at a glance. The process values are shown in easily readable programmable units. Either mg/l, % saturation or ppm can be chosen.

The user-interface is simplified to a basic set of 6 keys accessible through the flexible window cover. It uses a simple step by step, question and answer style to communicate with the operator by giving messages on the second line of the display and indicating which keys are to be pressed in the display.

Automatic air calibration

Calibration for a dissolved oxygen instrument is performed by simple air calibration (please refer to 6.3.1 section for the optical sensor).

Criteria for automatic calibration (stabilization time, DO values) can be set to suit the sensor.

In addition to the air calibration three additional calibration procedures can be used:

1. Span calibration using air saturated water
2. Zero calibration using sulfite saturated water
3. Process calibration using laboratory reference method

Alarm and control functions

The EXA DO402 has four built-in relay contacts. From the factory the first two contacts are pre-defined as a high or low alarm.

The third contact is pre-defined as a wash contact. This wash contact is driven by a wash-timer with adjustable wash-time, interval time and relaxation time to control the wash cycle.

The fourth contact is fixed to function as an alarm, indicating that the EXA has found a fault in the measuring loop. FAIL safe.

Cleaning

In combination with the appropriate sensor and immersion type fitting the wash timer with remote start possibility can be used. Interval-time, washing time and relaxation time are free programmable.

Damping time on output signal

Under certain circumstances disturbances can cause high peaks in the output signal. To avoid these disturbances the EXA DO402 has an electronic filtering which averages the output signal during a programmable period. This damping time is programmable between 0 and 120 seconds.

Salinity compensation

In order to take the effect of salinity into account for oxygen measurement an average chloride concentration can be programmed. The chloride concentration value is set manually via the service level. The EXA DO402 takes account of the effects of salinity and temperature simultaneously. The advantage of this construction is that the result of the measurement is available immediately. A separate conversion table is not necessary.

Temperature compensation

The micro-processor makes an accurate temperature compensation possible that performs well over the entire range of the instrument. No further adjustment tables are required.

Barometric air pressure compensation

Air pressure differences, due to weather conditions or altitude, can cause a variation up to 20 % in the dissolved oxygen concentration. A built-in air pressure sensor automatically compensates for barometric influences between 900 to 1100 mbar (90 to 110 kPa).

Sensor diagnostics

The DO sensor is checked for low impedance between the silver electrode and an earth contact in the liquid, to detect membrane integrity. Temperature sensor connections and sensor connections are checked for impedance. These faults are signalled by the FAIL contact and can be signalled to the control room by an output of 0/3.5 mA or 22 mA. The fault is also signalled by a special marker held on the display, a LED on the front and an error code in the message display.

During calibration of a DO measuring system the slope deviation from nominal value (%) and sensor output (µA) at 0 mg/l are calculated and checked.

If any of these are outside the limits, an error is signalled.

Logbook

Software record of important events and diagnostic data. Available through RS485, for use with the Yokogawa PC402 communication software.

Serial Communication

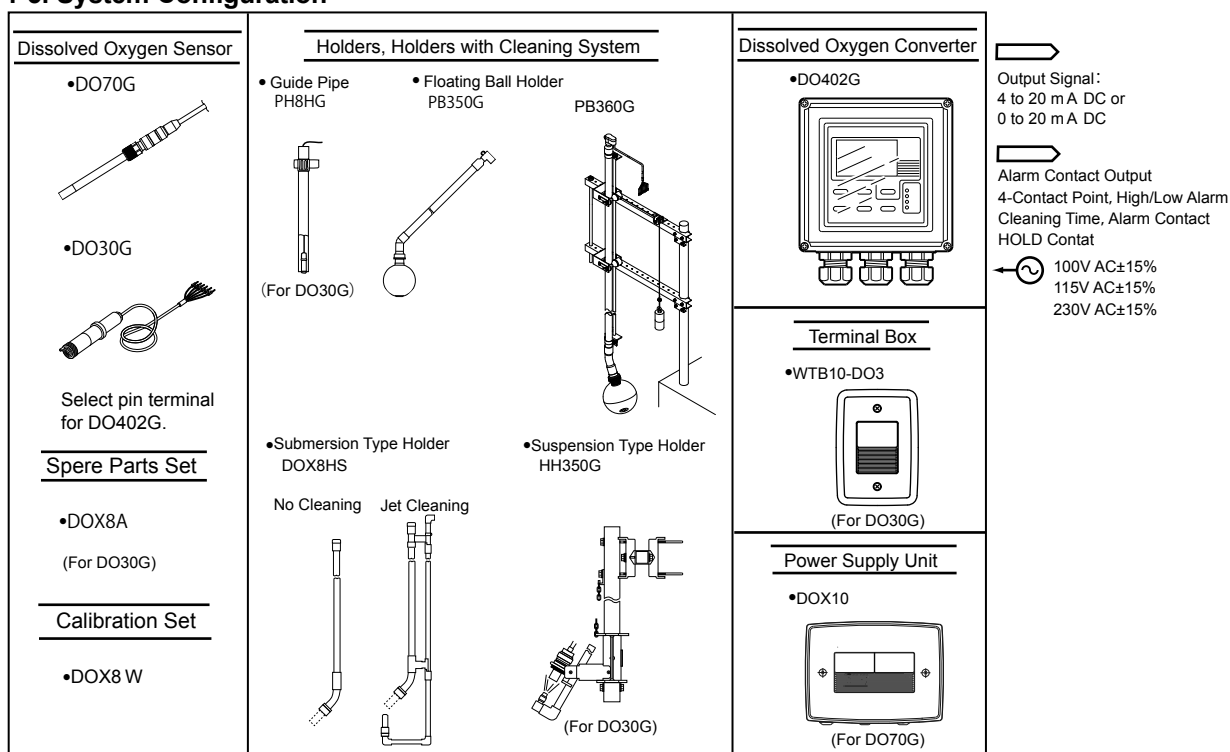
Bi-directional according to the EIA-485 standard using HART-protocol and PC402 software.

1-4. Configuration checklist for DO402

	Standard configuration	Options	Reference for change
Measured variable(s) Primary inputs DO range DO units Temperature range Temperature unit	D.O. and Temp 0- 20 mg/l mg/l 0- 50 °C Celsius	any span within 0-50 mg/l ppm. % saturation 25 °C minimum span Fahrenheit	"range" code 56 "range" code 11
Outputs Analog output Second output Output allocation Contact outputs Contact allocation Contact variables Add. contact functions Control functions Digital outputs	4- 20 mA for DO 4- 20 mA for Temp DO and Temp S1= high at 19.5 mg/l S2= low at 1.0 mg/l mg/l and FAIL dead time= 0.2 s; hyst= 0.1 mg/l none none none	0-20 mA or 4-20 mA 0-20 mA or 4-20mA DO, Temp, Table, PI control (4) freely programmable mg/l, temp, wash, PI control, HOLD time: 0- 200 s; hyst 0- 20 mg/l time out alarm PI on contacts or mA2 output RS485	code 30 code 30 code 31 "setpoint" code 40, 41, 42, 43 code 40- 43 code 44 code 47 code 45, 46, 34 33 code 60
Communication Digital interface Communication software Variables on display Burn out Password protection Autoreturn Add. functions in MAINT	disabled disabled mg/l and temp disabled disabled return to measure in 10 minutes disabled	RS485 PC402 %sat, °C, mA1, mA2, SL, ZR, REL burn low (3.5)/ high (22) on mA1/ mA2 for mains/ comm./ serv level enable or disable wash start/ setpoint adj	code 60 contact factory "display" code 32 code 52 code 50 code 51
Diagnostics Membrane condition Check on Slope Check on zero Check on stability	active active disabled 0.05 mg/l per 60 s	enable or disable enable or disable enable or disable 0-50 mg/l in 10-600 s	code 02 code 02, 22 code 02, 21, 22 code 20
Compatibility DO Sensor Temperature sensor Membrane thickness Sensor principle Manual temp. comp.	DO30 Pt1000 50 µm (2 mil) galvanic disabled	DOX8, DO410, Ingold, DO70G Pt 100, PB36, 22k NTC 25 or 50 µm (1 or 2 mil), adj. slope galvanic or polarographic *1 disable or enable	code 01, 10 code 10 code 01 code 01, "wiring" code 13
Special Features Salinity compensation Temperature calibration Zero calibration Sensor washing HOLD during maintenance Contact during HOLD Atm. press. compensation Soft fail alarm Logbook	disabled none disabled disabled disabled disabled active disabled disabled	comp. for 0- 100 ppt NaCl adjustment +/- 7.5 °C disable or enable interval < 36 hours, wash time 0.1-10 min. hold last or hold fix possible on S1,S2, S3 or S4 active or manual possible for E1..E4, E7..E9, E12, E16, E22 2 volumes of 50 events	code 04 code 12 code 21 "Wash" "Hold" code 40-42 code 53 code 61,62

*1: Choose a polarographic sensor for an optical dissolved oxygen sensor.

1-5. System Configuration



F01.EPS

1-5-1. Dissolved Oxygen Sensor

The DO402G can be used with a variety of sensors. Some specific programming may be necessary to match the converter with the sensor.

a. DO70G sensor

This sensor features temperature compensation with a 22k NTC RTD. The nominal output of this sensor is 60 nA in air under reference conditions. Before use, enter the service mode. Select service code 01 (*S.TYPE) and set it to 1 (polarographic sensor), then press the ENT key. Select *1.CELL2.9 and set the nominal output to 60 nA. Next, select service code 10 (*T.SENS) and set it to 3 (22k NTC). Then select service code 21 (*O.CAL) and set it to 1 (zero calibration enabled) because two-point calibration by air-saturated water calibration and zero calibration are required.

For details, refer to GS12J05D04-01E.

b. Model DOX8SM sensor

This sensor is a galvanic sensor with a PB36 type temperature compensator and a 25 micron membrane (1 mil).

This sensor has a nominal output current of 7.5µA in ambient air under reference conditions. In Service code 01 selection 1 must be programmed when this sensor is used. The membrane check is inactive with this sensor unless external solution ground is used. (metal holder or sample line)

c. Model DO30G sensor

This sensor is essentially the same as the DOX8SM sensor, but it has a 50 micron membrane, fixed sensor cable, Pt1000 RTD temperature compensation and integral solution ground that allows membrane checking. The nominal output of this sensor is 3.75 µA in air under reference conditions. In Service item "I.CELL" selection 0 must be programmed when this sensor is used.

For details, refer to GS12J05D03-01E.

d. Model DO30 sensor

This sensor is specified in GS12J6K4 and it can be supplied with 50 or with 25 micron membrane. Normally 50 micron membrane is used and no reprogramming is necessary. Otherwise Service code 01 setting must be changed from 0 to 1.

e. Ingold model 32 sensors with 12, 19 and 25 mm shaft

These sensors are available in many different configurations. The sensor is a polarographic sensor and therefore settings of service code 01 has to be changed from 0 to 1.

The sensor output is normally between 30 and 100 nA in ambient air under reference conditions, but the “large cathode” version has a current output between 200 and 700 nA. To utilize Slope diagnostic features, it is best to read current output during first air calibration in “display” mode and to enter that value in service code 01.

The temperature compensator is a NTC resistance and that can be chosen by entry of 3 in code 10.

The wiring of the sensor is different as well:

The red wire: the anode goes to terminal 18

The white wire: the cathode goes to terminal 17

The green/yellow wire: the shield goes to terminal 14 and the 2 black wires for NTC go to terminal 11 and 12.

The membrane checking feature cannot be used for these sensors, due to the construction of the sensor.

1-5-2. The holders**a. PB30 floating ball holder**

All Yokogawa sensors are compatible with the floating ball holder that is specified in GS12J6K4 and GS12J5A1.

b. FD30 immersion fitting

The DO30 sensor is compatible with the FD30 immersion holder as specified in GS12J6K4 and with all flow fittings and flow fitting subassemblies that are specified in GS12D7K2.

c. DOX8HS submersion type holder

The DOX8SM and the DO30G sensor are compatible with the DOX8HS holder and all PH8 model holders.

2. DO402G SPECIFICATIONS

2-1. General

A. Input specifications

: The DO402G Dissolved Oxygen converter measures the current, that is generated by the Dissolved Oxygen sensor. The flexibility of the input circuit allows the use of many commercially available sensors, whether they are of the Galvanic type (driving voltage generated internally) or Polarographic type (driving voltage supplied by converter)
The input range varies from 0.0 nA up to 500 nA for optical, polarographic sensors and 0.0 to 50 μ A for galvanic sensors. Temperature measurement for automatic temperature compensation utilizes Pt100, PT1000 RTD elements or PB36 as used in DOX8, DO30 and DO70G sensors, as well as the 22 k NTC as used by the Hamilton Oxyferm.

B. Measurement ranges

- DO : 0- 50 mg/l (ppm)
- Temperature: 0- 50 °C (32- 122 °F)

C. Span

- DO concentration
 - : minimum: 1 mg/l (ppm)
 - maximum: 50 mg/l (ppm)
- % saturation : minimum: 10 %
- maximum: 300 %
- Temperature: minimum: 25 °C (77 °F)
- maximum: 50 °C (122 °F)

D. Output Signals

: Two isolated outputs of 0/4- 20 mA DC with common negative. Maximum load 600 Ohm. Auxiliary output can be chosen from Temperature, DO, PI control, table, burn up (22 mA) or burn down (0 or 3.5 mA) to signal failure

E. Temperature compensation

: 0- 50 °C
Sensor types: Pt100 or Pt1000 RTD; PB36 (Yokogawa compatible);
22 k NTC (Ingold compatible)
Automatic or Manual temperature compensation

F. Calibration

: Semi-automatic calibration with automatic compensation for influence of barometric pressure and altitude on partial pressure of oxygen in air (or solubility of oxygen in water). Automatic compensation for influence of salinity of water on solubility of oxygen in water is programmable.
The correction for pressure, salinity and temperature meets ISO 5814

Possible calibration routines are:

- Slope (span) calibration in ambient air. The calibration table is based on 70 % RH and is determined empirically.
- Slope (span) calibration in water, saturated with air: according ISO 5814
- Zero calibration (normally inactive)

G. Serial Communication

: Bi-directional according to the EIA-485 standard using HART protocol and PC402 software.

H. Logbook

: Software record of important events and diagnostic data. Available through RS485, with key diagnostic information available in the display.

I. Display

: Custom liquid crystal display, with a main display of 3½ digits 12.5 mm high. Message display of 6 alphanumeric characters, 7 mm high.

2-2 Specification

J. Contact outputs

- General : Four (4) SPDT relay contacts with LED indicators. For S1, S2, and S3, the LED is on when relay is powered.

NOTE:

For S4 (FAIL) LED lights when power is removed (Fail safe). Contact outputs configurable for hysteresis and delay time.

- Capacity : Maximum values 100 VA, 250 V AC, 5 Amps.
Maximum values 50 Watts, 250 V DC, 5 Amps.
- Status : High/Low process alarms, selected from process parameters and temperature. Contact output is also available to signal "Hold Active"

Status	Contact S1 to S3			Contact S4		
	LED	NO	NC	LED	ON	NC
Alarm, FAIL, OFF	On	Closed	Open	On	Open	Closed
Alarm, FAIL, OFF	Off	Open	Closed	Off	Closed	Open
Power OFF	Off	Open	Closed	Off	Open	Closed

- Control function : On/Off
- PI pulsed : Proportional duty cycle control with integral term.
- PI frequency : Proportional frequency control with integral term. In addition wash cleaning control signal on S3, and FAIL alarm for system and diagnostic errors on S4

K. Contact input: Wash start or input remote range change (either choice)

- On resistance: 10Ω or less
- Off resistance: 100kΩ or more
- On time: 0.5 sec. or more

L. Power supply

- Supply voltage rating : 100, 115, 230 VAC
- Applicable range : 85 to 115, 97.8 to 132.2, 195.5 to 264.5 VAC
- Supply frequency rating : 50 / 60 Hz
- Applicable range : 50 Hz ± 5% / 60 Hz ± 5%

Power consumption

- : Maximum 10 VA for steady operation

M. Safety and EMC conforming standards



- Safety:** conforms to EN 61010-1
- EMC:** EN 61326-1 Class A, Table 2 (For use in industrial locations) (Note 1)
EN 61326-2-3
EN 61000-3-2 Class A
EN 61000-3-3
EMC Regulatory Arrangement in Australia and New Zealand
EN 55011 Class A, Group 1
Korea Electromagnetic Conformity Standard Class A
한국 전자파적합성 기준

- Installation altitude: 2000 m or less
- Category based on IEC 61010: II (Note 2)
- Pollution degree based on IEC 61010:2 (Note 2)

Note 1: This instrument is a Class A product, and it is designed for use in the industrial environment. Please use this instrument in the industrial environment only.

A급 기기 (업무용 방송통신기자재)

이 기기는 업무용(A급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다.

Note 2: Installation category, called over-voltage category, specifies impulse withstand voltage. Category II is for electrical equipment. Pollution degree indicates the degree of existence of solid, liquid, gas or other inclusions which may reduce dielectric strength. Degree 2 is the normal indoor environment.

N. Shipping details

- : Package size w x h x d
290 x 300 x 290 mm.
11.5 x 11.8 x 11.5 in.
- Packed weight approx.
2.5 kg (5lb).

2-2. Operating specifications

A. Performance : DO (at t process = 25 °C)

- Linearity : ± 0.03 mg/l or ± 0.5%FS, whichever is greater
- Repeatability: ± 0.03 mg/l or ± 0.5%FS, whichever is greater
- Accuracy : ± 0.05 mg/l or ± 0.5%FS, whichever is greater

B. Performance : Temperature (Pt1000, PB36, 22kNTC)

- Linearity : $\pm 0.3\text{ }^{\circ}\text{C}$
- Repeatability : $\pm 0.1\text{ }^{\circ}\text{C}$
- Accuracy : $\pm 0.3\text{ }^{\circ}\text{C}$

Performance : Temperature (Pt100)

- Linearity : $\pm 0.4\text{ }^{\circ}\text{C}$
- Repeatability : $\pm 0.1\text{ }^{\circ}\text{C}$
- Accuracy : $\pm 0.4\text{ }^{\circ}\text{C}$

Note on performance specifications:

The specifications are expressed with simulated inputs, because the DO402G can be used with many different sensors with their unique characteristics.

The following tolerance is added to above performance.

mA output tolerance : $\pm 0.02\text{ mA}$ of "0/4 - 20 mA"

Digital display tolerance : +1 digit

C. Response time

0- 90% : 10 s

D. Ambient operating temperature

: -10 to +55 $^{\circ}\text{C}$ (14 to 131 $^{\circ}\text{F}$)

E. Storage temperature

: -30 to +70 $^{\circ}\text{C}$ (-22 to 158 $^{\circ}\text{F}$)

F. Humidity : 10 to 90% RH non-condensing**G. Housing**

Case : Cast aluminium with chemically resistant coating

Cover : flexible polycarbonate window.

Case color : off-white (munsell 2.5Y8.4/1.2)

Cover color : moss green. (munsell 0.6GY3.1/2.0)

Cable entry : via six Pg13.5 nylon glands.

Cable terminals: for up to 2.5 mm² finished wires.

Protection : weather resistant to IP65 standards.

Mounting : Pipe, wall or panel, using optional bracket.

H. Data protection

: Non volatile memory for configuration and logbook, and lithium battery for clock support.

I. Watchdog timer

: Checks microprocessor

J. Automatic safeguard

: Return to measuring mode when no keystroke is made for 10 min.

K. Power interruption

: Less than 50 milliseconds no effect.

L. Operation protection

: 3-digit programmable password.

M. Connection via cables:

The distance between the ensor and trans mitter can be up to 50 m if the WTB10 junction box is used. This junction box can not be used for the DO70G, for which the allowable maximum distance is 10 m.

2-3. Model and suffix codes

[Style: S3]

Model	Suffix code	Option code	Description
DO402G	-----	-----	Dissolved Oxygen Converter
Type	-1	-----	General
Power Supply Voltage	-1	-----	115V +/-15% AC, 50/60 Hz
	-2	-----	230V +/-15% AC, 50/60 Hz
	-5	-----	100V +/-15% AC, 50/60 Hz
Language	-J	-----	Japanese
	-E	-----	English
Options			
Mounting Hardware	/U		Pipe, wall mounting bracket (Stainless steel)
	/PM		Panel mounting bracket (Stainless steel)
Hood	/H3		Hood for sun protection (Carbon steel)
	/H4		Hood for sun protection (Stainless steel)
Tag Plate	/SCT		Stainless steel tag plate
Conduit Adaptor	/AFTG		G 1/2
	/ANSI		1/2 NPT
Coating	/X1		Epoxy baked finish (*1)

*1: The housing is coated with epoxy resin.

3. INSTALLATION AND WIRING

3-1. Installation and dimensions

3-1-1. Installation site



WARNING

This instrument is a Class A product, and it is designed for use in the industrial environment. Please use this instrument in the industrial environment only.

The EXA converter is weatherproof and can be installed inside or outside. It should, however, be installed as close as possible to the sensor to avoid long cable runs between sensor and converter. In any case, the cable length should not exceed 50 meters (162 feet). For an optical dissolved oxygen sensor, the allowable maximum cable length is 10 m. Select an installation site where:

- Mechanical vibrations and shocks are negligible
- No relay/power switches are in the direct environment
- Access is possible to the cable glands (see figure 3-1)
- The converter is not mounted in direct sunlight or severe weather conditions
- Maintenance procedures are possible (avoiding corrosive environments)

The ambient temperature and humidity of the installation environment must be within the limits of the instrument specifications. (See chapter 2).

3-1-2. Mounting methods

Refer to figures 3-2 and 3-3. Note that the EXA converter has universal mounting capabilities:

- Panel mounting using optional brackets
- Surface mounting on a plate (using bolts from the back)
- Wall mounting on a bracket (for example, on a solid wall)
- Pipe mounting using a bracket on a horizontal or vertical pipe (maximum pipe diameter 50 A)

Unit: mm (inch)

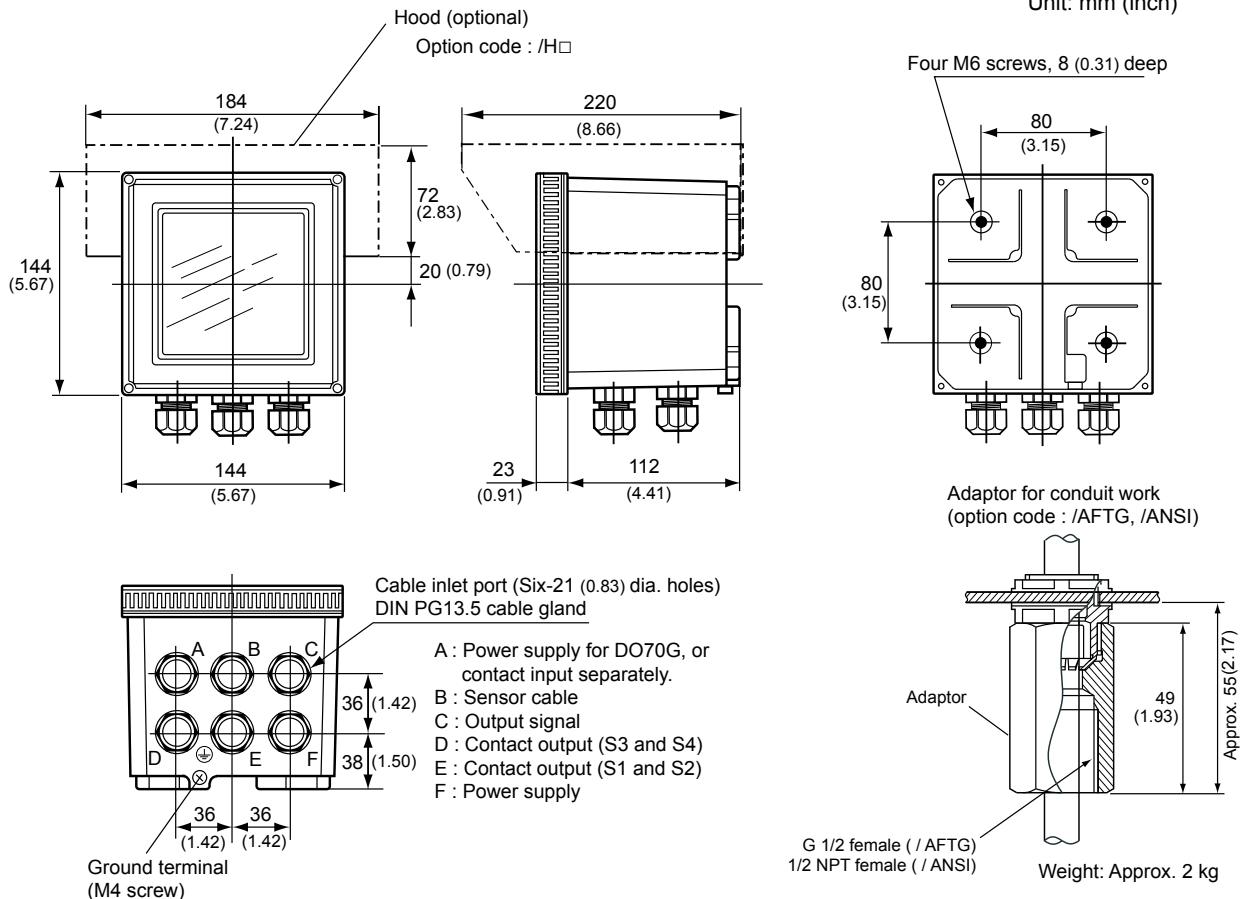


Figure 3-1. Housing dimensions and layout of glands

3-2 Installation and wiring

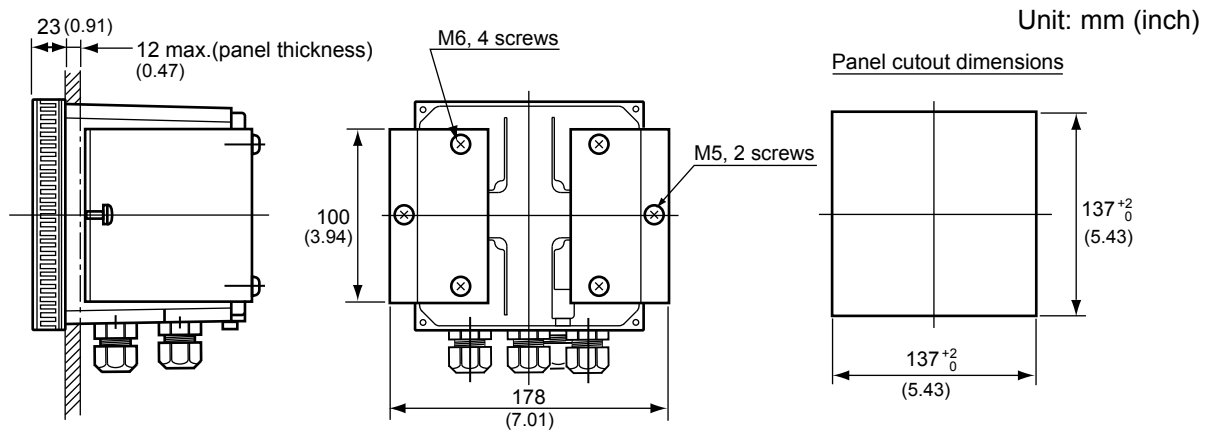
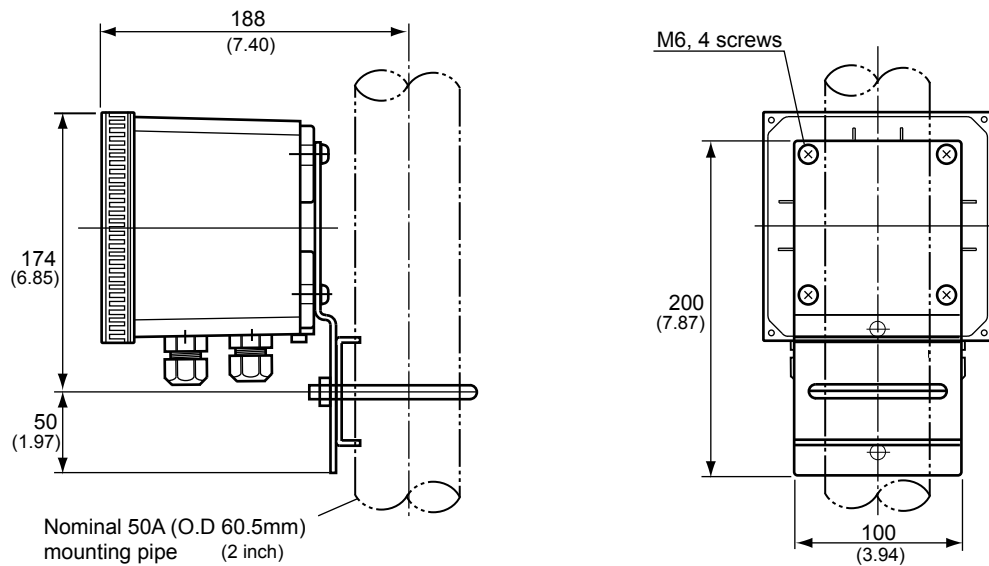


Figure 3-2 . Panel mounting diagram (Option Code: /PM)

Example of bracket used for pipe mounting



Example of bracket used for wall mounting

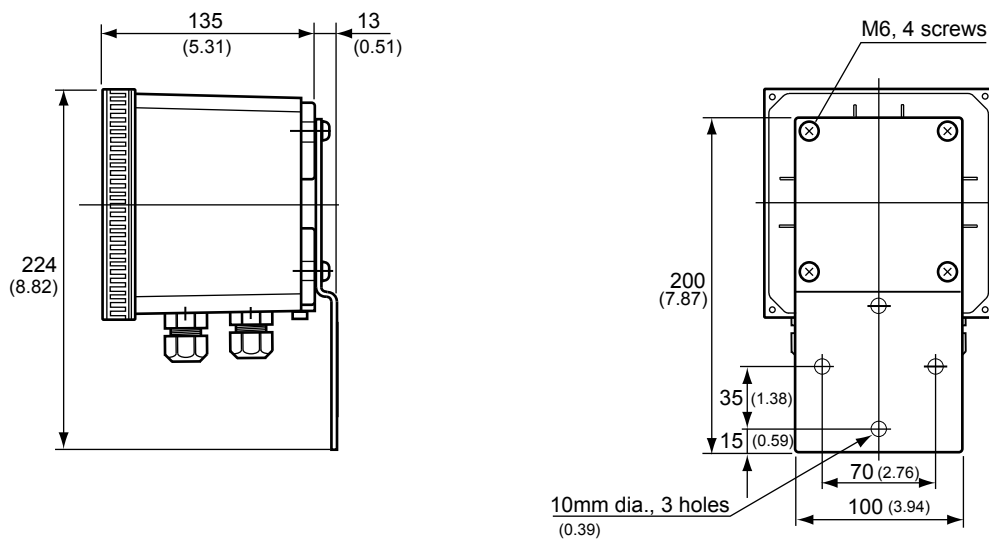


Figure 3-3. Wall and pipe mounting diagram (Option Code: /U)

3-2. Wiring

3-2-1. Wiring of DO30G

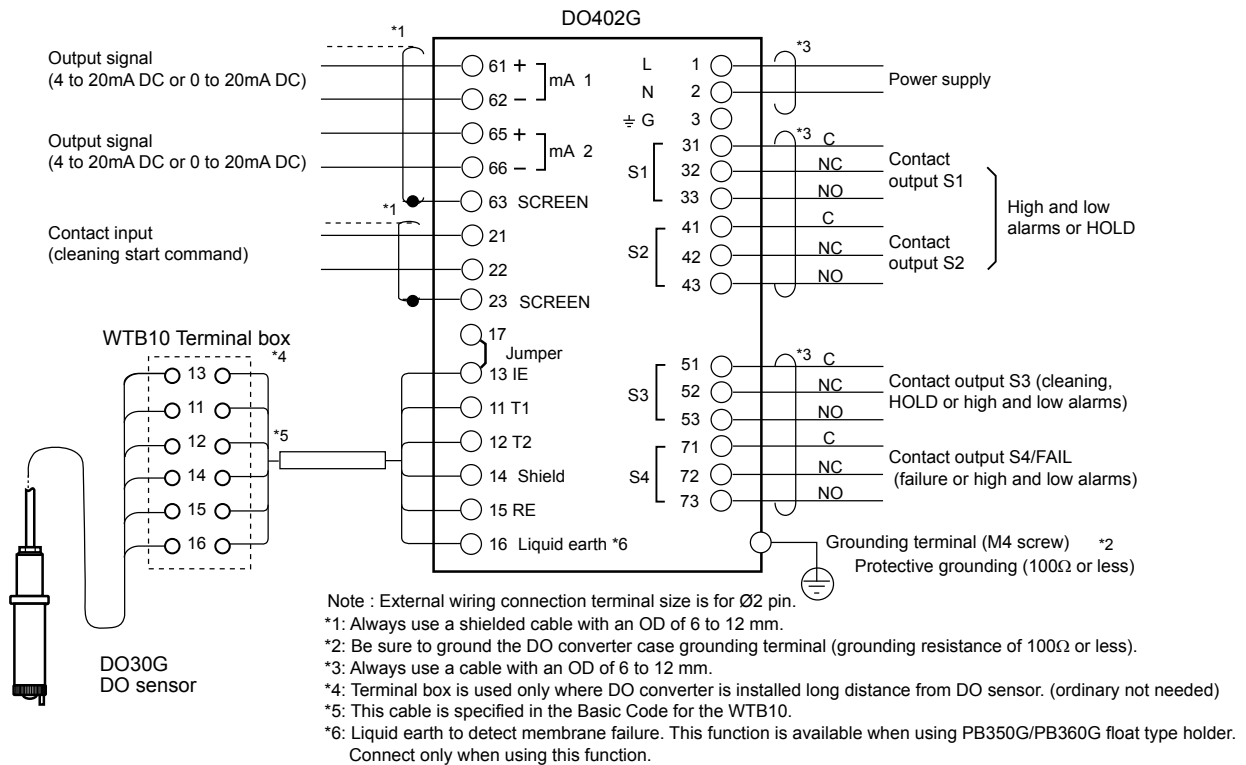


Figure 3-4. wiring of DO30G (Example)

3-2-2. Wiring of DO70G

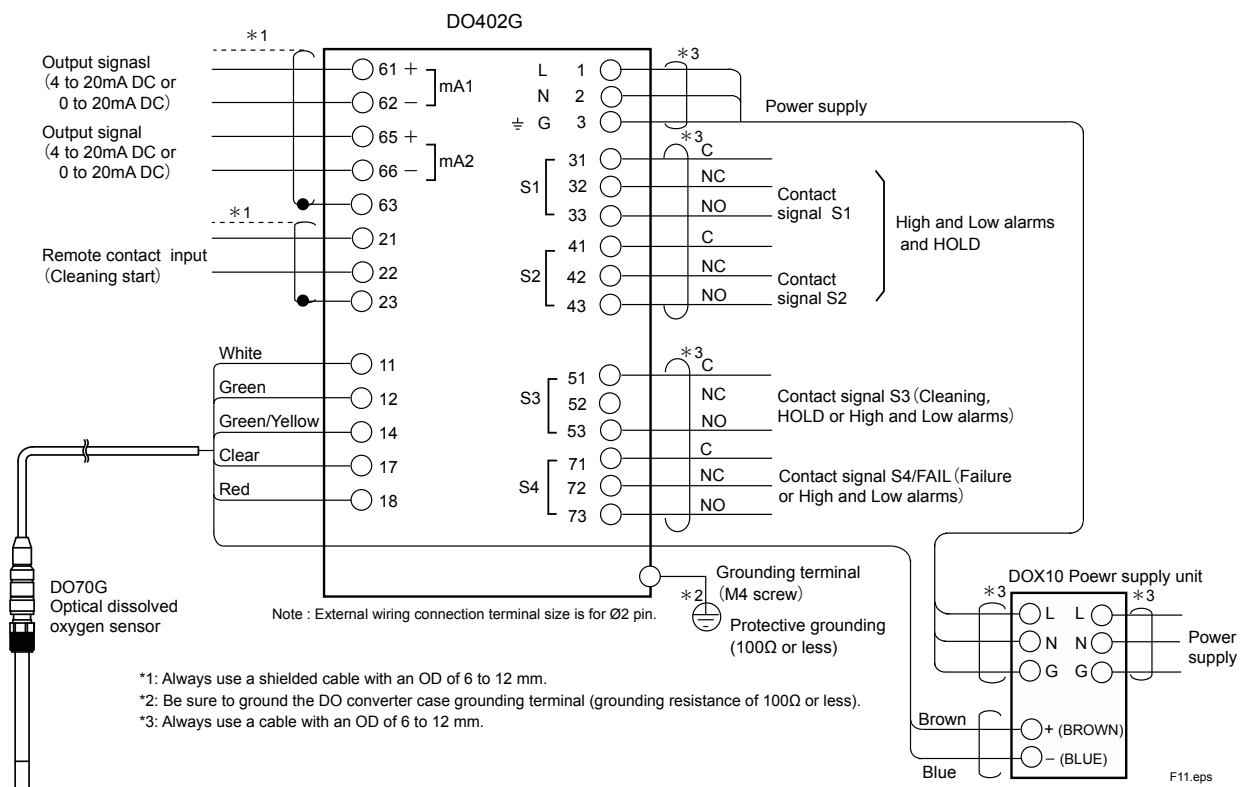


Figure 3-5. wiring of DO70G (Example)



DANGER

- Never apply power to the DO402G converter and other instruments connected to the DO402G converter until all wiring is completed.



WARNING

- This product complies with the CE marking.
Where compliance with the CE marking and relevant standard is necessary, the following wiring is required.
 1. Install an external switch or circuit breaker to the power supply of the DO402G converter.
 2. Use an external switch or circuit breaker rated 5A and conforming to IEC 60947-1 or IEC 60947-3.
 3. It is recommended that the external switch or circuit breaker be installed in the same room as the DO402G converter.
 4. The external switch or circuit breaker should be installed within reach of the operator and identified with marking as a power supply switch to the DO402G converter.
 5. Power lines such as power cables and contact outputs should be fixed securely onto a wall or construction using cable racks, conduit tubing, nylon bands or other appropriate ways. Accidental removal from terminals by pulling may result in electric shock.

3-2-3. Preparation

The relay contact terminals and power supply connections are under the screening (shielding) plate. These should be connected first. Connect the sensor, outputs and data communication connections last.

Follow the procedures below to open the DO402G for wiring:

1. Loosen the four frontplate screws and remove the cover.
2. Use the rubber knob in the lower right hand corner and swing open the display board to the left.
3. The upper terminal strip is now visible.
4. Remove the screen (shield) plate covering the lower terminal strip.
5. Connect the power supply and contact outputs. Use the three glands at the back for these cables.
6. Replace the screen (shield) plate over the lower terminals.



WARNING

Always replace the screen plate over the power and contact outputs for safety and to avoid interference.

7. Connect the analog output(s), the sensor input, the contact input and, if necessary, the RS485 serial bus.
8. Use the front three glands for analog output, sensor input, contact input and communication cabling (see figure 3-6).
9. Close the display board and switch on the power. Commission the instrument as required or use the default settings.
10. Replace the cover and secure frontplate with the four screws.
Tighten four frontplate screws to 1.5 N·m torque.

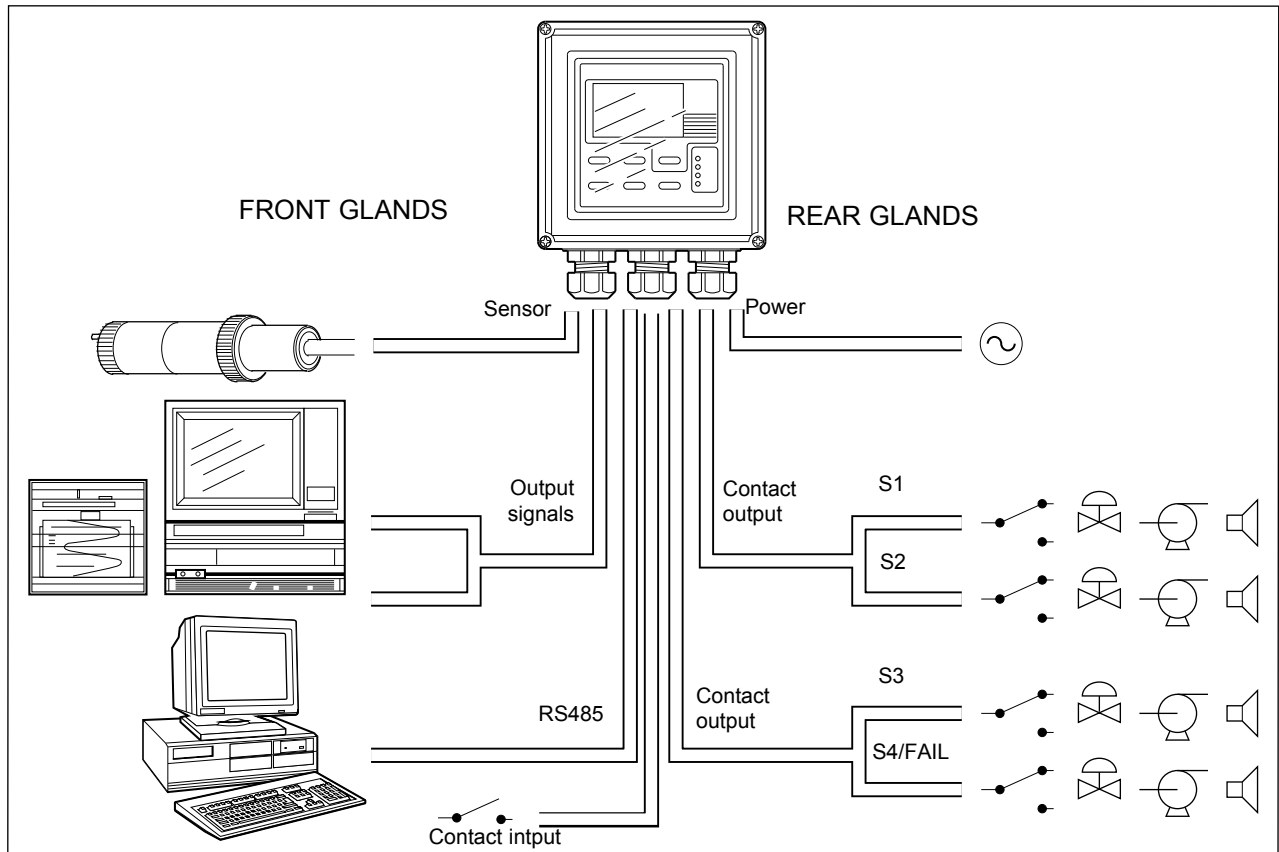


Figure 3-6. System configuration

3-3. Wiring the power supply

3-3-1. General precautions

Make sure the power supply is switched off. Also, make sure that the power supply is correct for the specifications of the EXA and that the supply agrees with the voltage specified on the textplate. Remove the front cover by unscrewing the four screws to check this textplate on the top of the display board.

Local health and safety regulations may require an external circuit breaker to be installed. The instrument is protected internally by a fuse. The fuse rating is dependent on the supply to the instrument. The 250 VAC fuses should be of the “time-lag” type, conforming to IEC60127.

The internal fuse is located next to the power terminals (in the lower right hand corner).



DANGER

Use only a fuse of the specified current, voltage and type ratings to prevent fire. For fuse replacement, refer to Section 7-3, “Fuse Replacement.”

3-6 Installation and wiring

3-3-2. Access to terminal and cable entry

Terminals 1 and 2 on the bottom terminal strip are used for the power supply. Guide the power cables through the gland closest to the power supply terminals. The terminals will accept wires of 2.5 mm² (14 AWG). Use cable finishings if possible.

Connect the wires as indicated in the wiring diagram (refer to figure 3-6).

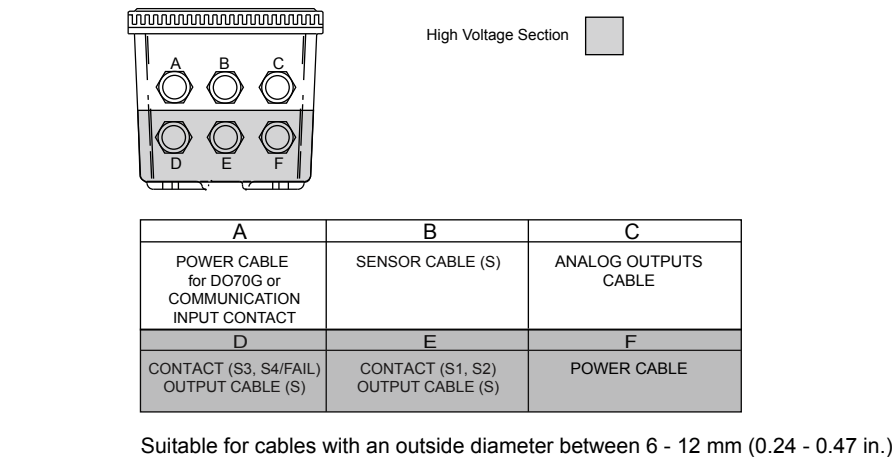
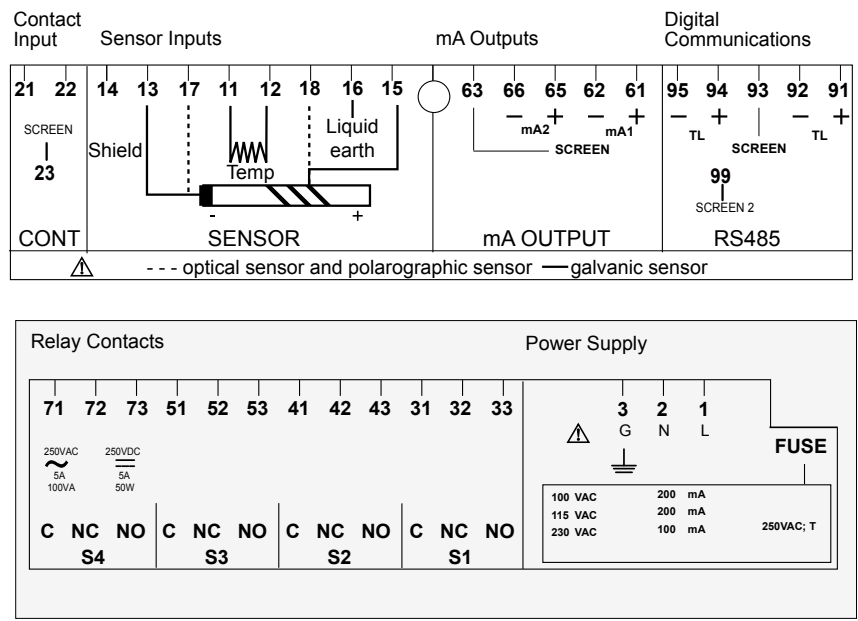


Figure 3-7. Glands to be used for cabling



High voltage compartment

Figure 3-8. Input and output connections

3-3-3. AC power

Connect terminal 1 to the phase line of the AC power and terminal 2 to the zero line. The size of conductors should be at least 1.25 mm². The overall cable diameter should be between 6 & 12 mm (0.24 & 0.47 in).

3-3-4. Grounding the housing**DANGER**

Protective grounding must be made to prevent electric shock.

To protect the instrument against interference, the housing should be connected to ground by a large area conductor. This cable can be fixed to the rear of the housing using a braided wire cable. See figure 3-9. This is separated from input ground by a galvanic isolation.

**CAUTION**

Please be sure to connect protective grounding of DO402G with cable of 1.25 mm² or larger cross section in order to avoid the electrical shock to the operators and maintenance engineers and prevent the influence of external noise. And further connect the grounding wire to the $\oplus$ mark (100Ω or less).

3-3-5. Switching on the instrument

After all connections are made and checked, the power can be switched on from the power supply. Make sure the LCD display comes on. All segments will illuminate, then the instrument will momentarily display its unique serial number. After a brief interval, the display will change to the measured value. If errors are displayed or a valid measured value is not shown, consult the troubleshooting section (Chapter 8) before calling Yokogawa.

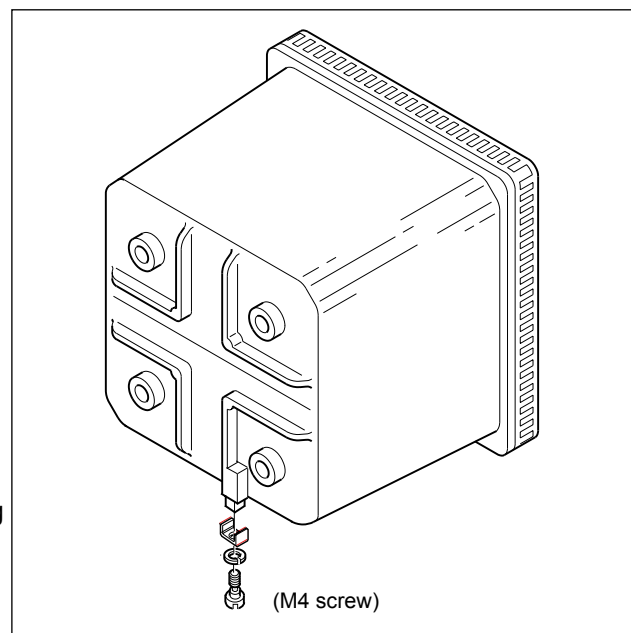


Figure 3-9. Grounding the housing

3-4. Wiring the contact signals

3-4-1. General precautions

The contact output signals consist of voltage-free relay contacts for switching electrical appliances (SPDT). They can also be used as digital outputs to signal processing equipment (such as a controller or PLC). It is possible to use multi-core cables for the contact in and output signals and shielded multi-core cable for the analog signals.

3-4-2. Contact outputs

The EXA unit's four contact outputs can be wired to suit your own custom requirements (Figure 3-6).

In the Non-Alarm or Power Off states, contacts S1, S2 and S3 are OFF, Common (C) and Normally Closed (NC) are in contact.

In the "Fail" or Power Off states, contact S4 is ON, Common (C) and Normally Closed (NC) are in contact.

You can either use them to switch AC power, or switch a DC Voltage for digital interfacing.

Default settings

- The contact S1 is pre-programmed for high alarm function.
- The contact S2 is pre-programmed for a low alarm function.
- The contact S3 is pre-programmed for wash function.
- The contact S4 is pre-programmed for FAIL.



WARNING

The three control contacts (S1 to S3) can be used for simple process control by programming their function (Chapter 5). The FAIL contact is programmed to signal a fault in the measuring loop. Always connect the FAIL contact to an alarm device such as a warning light, sound annunciator, or alarm panel to make full use of the fault detection possibilities (self diagnostics) of the EXA converter.

3-4-3. Contact input

It is necessary to use screening/shielding on the output signal cables. Screw (M3) 23 is used to connect the shielding.

On resistance: 10Ω or less

Off resistance: 100kΩ or more

3-5. Wiring the analog output signals

3-5-1. General precautions

The analog output signals of the EXA transmit low power standard industry signals to peripherals like control systems or strip-chart recorders (Figure 3-6).

3-5-2. Analog output signals

The output signals consist of active current signals of either 0-20 mA or 4-20 mA. The maximum load can be 600 ohms on each.

It should be necessary to use screening/shielding on the output signal cables. Terminal 63 is used to connect the shielding.

3-6. Wiring the standard galvanic sensor

The sensor cable has markers on the individual wires. These markings refer to the markers on the terminals.

The temperature compensator has two wires with the markings T1, T2 and/or 11, 12 and must be connected to terminal 11 and 12.

The measuring electrode: the cathode is marked with IE and/or 13 and must be connected to terminal 13.

The reference electrode: the anode is marked with RE and/or 15 and must be connected to terminal 15.

The liquid earth (solution ground) is marked with 16 and must be connected to terminal 16.

Note:

The liquid earth (solution ground) connection is valid only when the floating ball holder, Model PB350G or PB360G, is used. Otherwise, do not make a connection to terminal 16. The connection, if made, may result in abnormal readings. Even if the floating ball holder is used, when the liquid earth (solution ground) connection is not used, then disconnect the wiring to terminal 16. (The disconnected wire should be covered with an insulating tube to avoid contact with other terminals.)

The overall shield of the cable is marked with 14 and must be connected to terminal 14.

Note:

A jumper cable is placed to connect converter terminals 13 and 17.

Make sure that connecting the sensor cable to the IE pin or pin 13 or pulling the sensor cable does not cause the jumper cable to come loose. Insufficient tightening may cause unstable or false measurements.

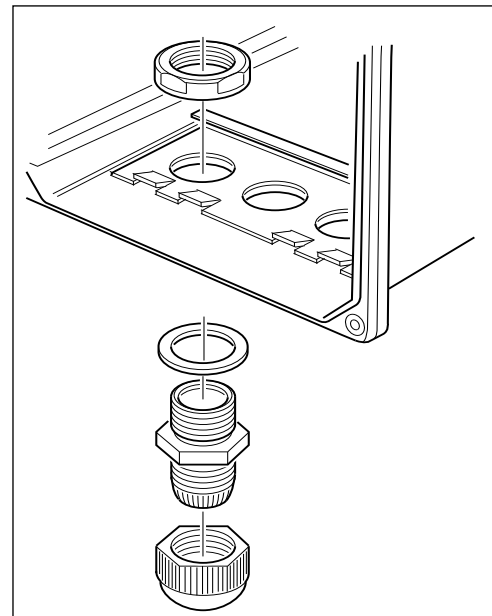
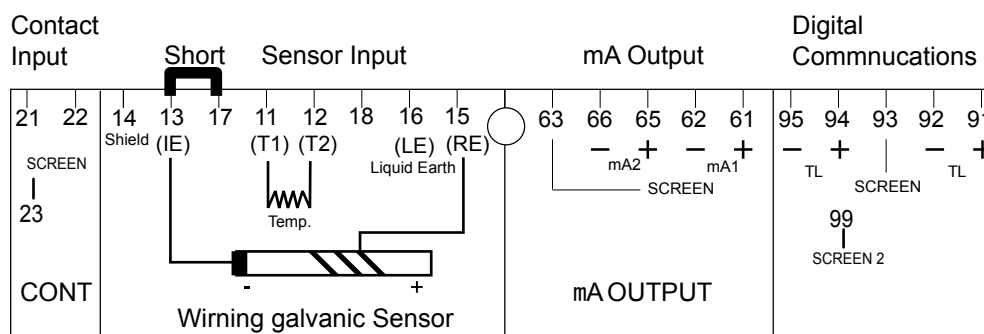


Figure 3-10. Cable gland assembly



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Figure 3-11. Wiring galvanic sensor

3-7. Wiring other galvanic sensors

Consult the users manual for the color identification of the sensor cable and connect temperature compensator, cathode and anode to the terminals: 11, 12, 13 and 15 as described above. Connect the cable shield to 14 if there is one available. Sensor diagnostics is normally not possible.

Note:

A jumper cable is placed to connect converter terminals 13 and 17.
Make sure that connecting the sensor cable to the IE pin or pin 13 or pulling the sensor cable does not cause the jumper cable to come loose. Insufficient tightening may cause unstable or false measurements.

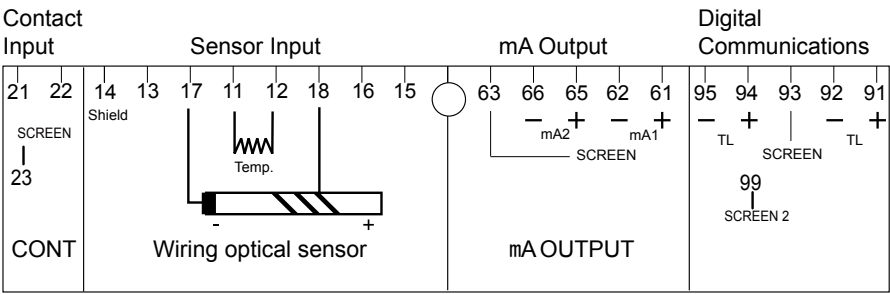
3-8. Wiring the standard optical sensor (DO70G)

Note:

A jumper cable is placed to connect converter terminals 13 and 17.
When a standard optical sensor (DO70G) is to be connected, the cable is not used, so disconnect it. It is recommended to save the jumper cable for future use—if may be needed when a galvanic sensor is used.

The color of the wiring of the sensor cable supports the indication of each terminal.

Color of sensor cable	White	Green	Green/Yellow	Clear	Red	Brown	Blue
DO402G	11	12	14	17	18		
DOX10						+	-



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Figure 3-12. Wiring optical sensor

DO70G Wiring Diagram Example

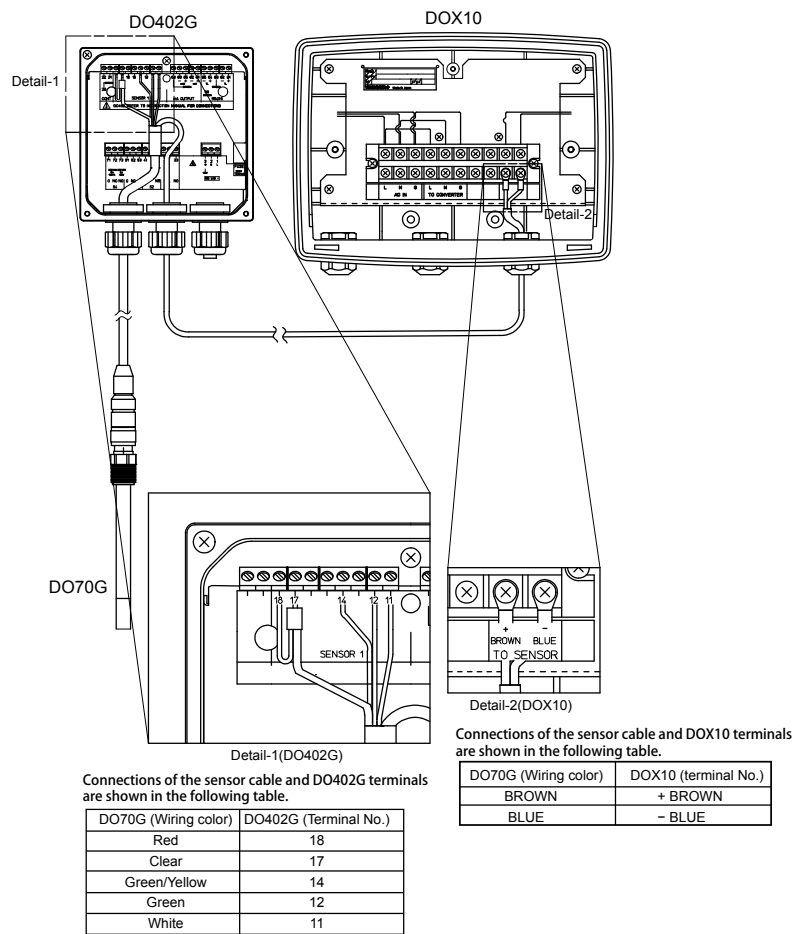


Figure 3-13. Wiring optical sensor (DO70G)

3-9. Wiring polarographic sensors

Consult the owners manual for the color identification of the sensor cable and connect temperature compensator, cathode and anode to terminals 11, 12, 17 and 18 in this sequence. Connect the cable shield (when provided) to terminal 14.

Note:

- A jumper cable is placed to connect converter terminals 13 and 17.
- When a polarographic sensor is to be connected, the cable is not used, so disconnect it.
- It is recommended to save the jumper cable for future use—if may be needed when a galvanic sensor is used.

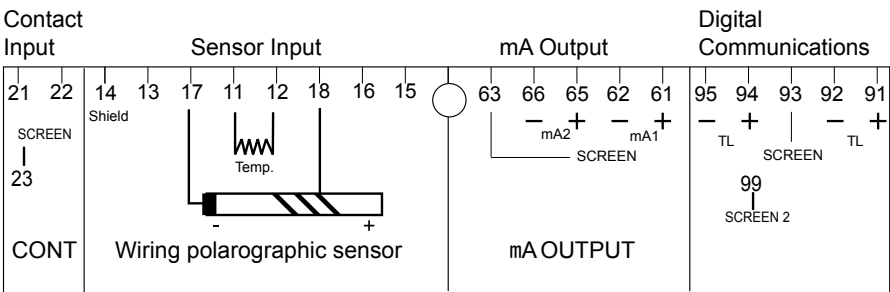


Figure 3-14. Wiring polarographic sensor

3-10. Wiring RS485 signal

It is necessary to use screening/shielding on the output signal cables. Screw (M3) 99 is used to connect the shielding.

4. OPERATION; DISPLAY FUNCTIONS AND SETTING

4-1. Operator interface

This section provides an overview of the operation of the EXA operator interface. The basic procedures for obtaining access to the three levels of operation are described briefly. For a step-by-step guide to data entry, refer to the relevant section of this instruction manual. Figure 4-1 shows the EXA operator interface.

LEVEL 1: Maintenance

These functions are accessible by pushbutton through a flexible front cover window. The functions make up the normal day-to-day operations that an operator may be required to complete. Adjustment of the display and routine calibration are among the features accessible in this way. (See table 4-1).

LEVEL 2: Commissioning

A second menu is exposed when the EXA front cover is removed and the display board is revealed. Users gain access to this menu by pressing the button marked * in the lower right of the display board. This menu is used to set such values as the output ranges and hold and wash features. It also gives access to the service menu. (See table 4-1).

LEVEL 3: Service

For more advanced configuration selections, press the button marked * , then press “NO” repeatedly until you reach *SERV. Now push the “YES” button. Selecting and entering “Service Code” numbers in the commissioning menu provide access to the more advanced functions. An explanation of the Service Codes is listed in chapter 5 and an overview table is shown in chapter 10.

Table 4-1. Operations overview

	Routine	Function	Chapter
Maintenance (level 1)	AIR. CAL	Calibration in air (preferred method)	6
	H2O. CAL	Calibration in aerated water	6
	MAN. CAL	Process calibration based on grab sample	6
	DISP	Read auxiliary data and set message display	4
	HOLD	Switch HOLD on/off *)	5
	SETP	Adjust alarm setpoints *)	5
	WASH	Start wash cycle manually *)	5
	M.TEMP	Adjust manual temp*)	5
	M.PRESS	Adjust manual press	5
Commissioning (level 2)	*SETP	Adjust alarm setpoints	5
	*RANGE	Adjust output range(s)	5
	*HOLD	Activate HOLD function	5
	*WASH	Activate and configure the wash timer	5
Service (level 3)	*SERV	Configure the specialized functions of the converter	5

*) Only possible if activated

NOTE:

All three levels may be separately protected by a password. See Service Code 52 in chapter 5 Service Code table for details on setting passwords.

4-2 Operation

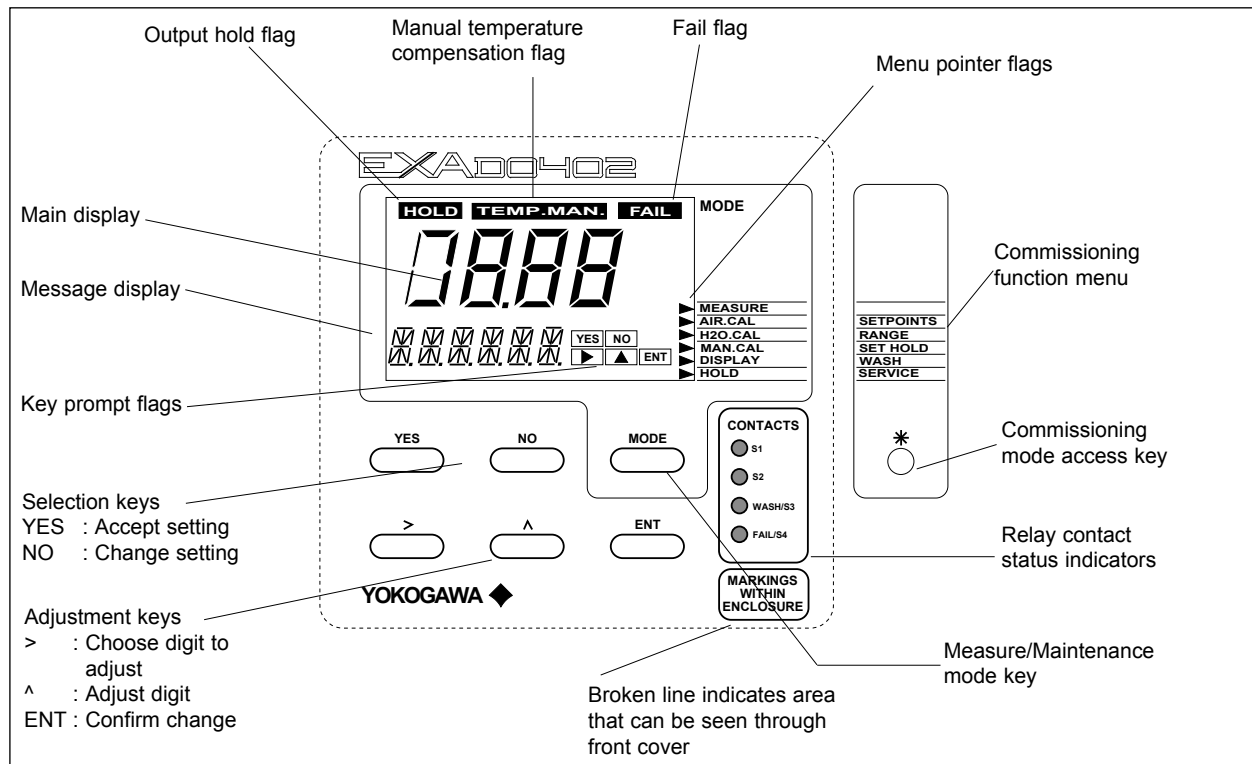


Figure 4-1. DO402 operator interface

4-2. Explanation of operating keys

MODE key This key toggles between the Measuring and Maintenance modes. Press once to obtain access to the maintenance function menu. (Level 1 see table 4-1)
Press again to return to the Measuring mode (press twice when hold is activated).

YES/NO keys These are used to select choices from the menu.

YES is used to accept a menu selection.

NO is used to reject a selection, or to move ahead to the next option.

DATA ENTRY keys (> ^ ENT)

> is used as a "cursor" key. Each press on this key moves the cursor or flashing digit one place to the right. This is used to select the digit to be changed when entering numerical data.

^ is used to change the value of a selected digit. Each press on this key increases the value by one unit. The value can not be decreased, so in order to obtain a lower value, increase past nine to zero, then increase to the required number.

ENT When the required value has been set using the > and ^ keys, press ENT to confirm the data entry. Please note that the EXA 402 does not register any change of data until the ENT key is pressed.

*** key**

This is the Commissioning mode key. It is used to obtain access to the Commissioning menu. This can only be done with the cover removed or opened. Once this button has been used to initiate the Commissioning menu, follow the prompts and use the other keys as described above.

4-3. Setting passcodes

In Service Code 52, EXA users can set passcode protection for each one of the three operating levels, or for any one or two of the three levels. This procedure should be completed after the initial commissioning (setup) of the instrument. The passcodes should then be recorded safely for future reference.

When passcodes have been set, the following additional steps are introduced to the configuration and programming operations:

Maintenance

Press MODE key. The display shows 000 and *PASS*

Enter a 3-digit passcode as set in Service Code 52 to obtain access to the Maintenance Mode

Commissioning

Press * key. The display shows 000 and *PASS*

Enter a 3-digit passcode as set in Service Code 52 to obtain access to the Commissioning Mode.

Service

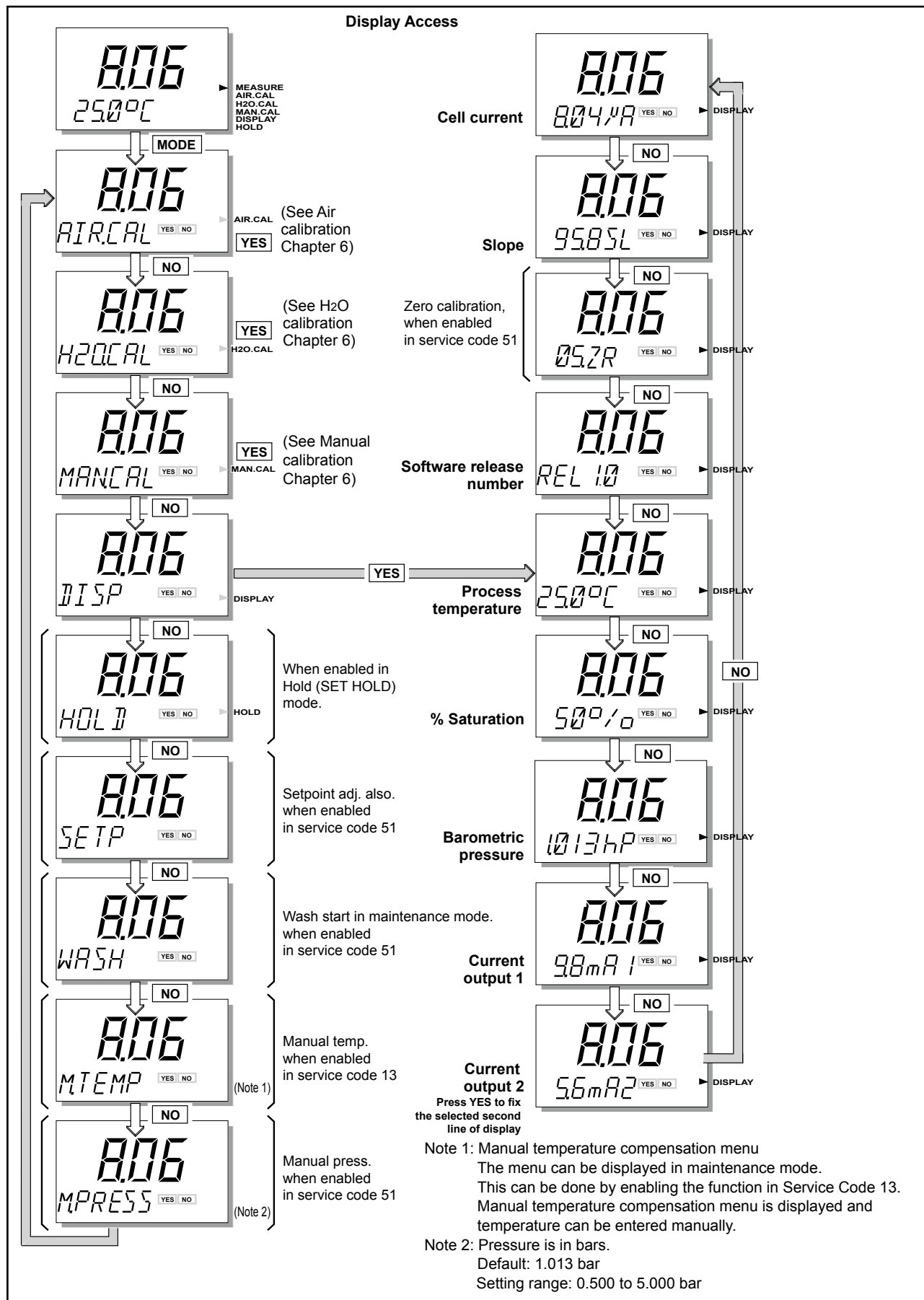
From the commissioning menu, select *SERV by pressing YES key. The display shows 000 and *PASS*

Enter a 3-digit passcode as set in Service Code 52 to obtain access to the Service Mode.

NOTE:

See Service Code 52 for the setting of passcodes.

4-4. Display functions (default)



5. PARAMETER SETTING

5-1. Maintenance mode

Standard operation of the EXA instrument involves use of the maintenance (or operating) mode to set up some of the parameters.

Access to the Maintenance mode is available via the six keys that can be pressed through the flexible window in the instrument cover. Press the MODE key once to enter this dialog mode.

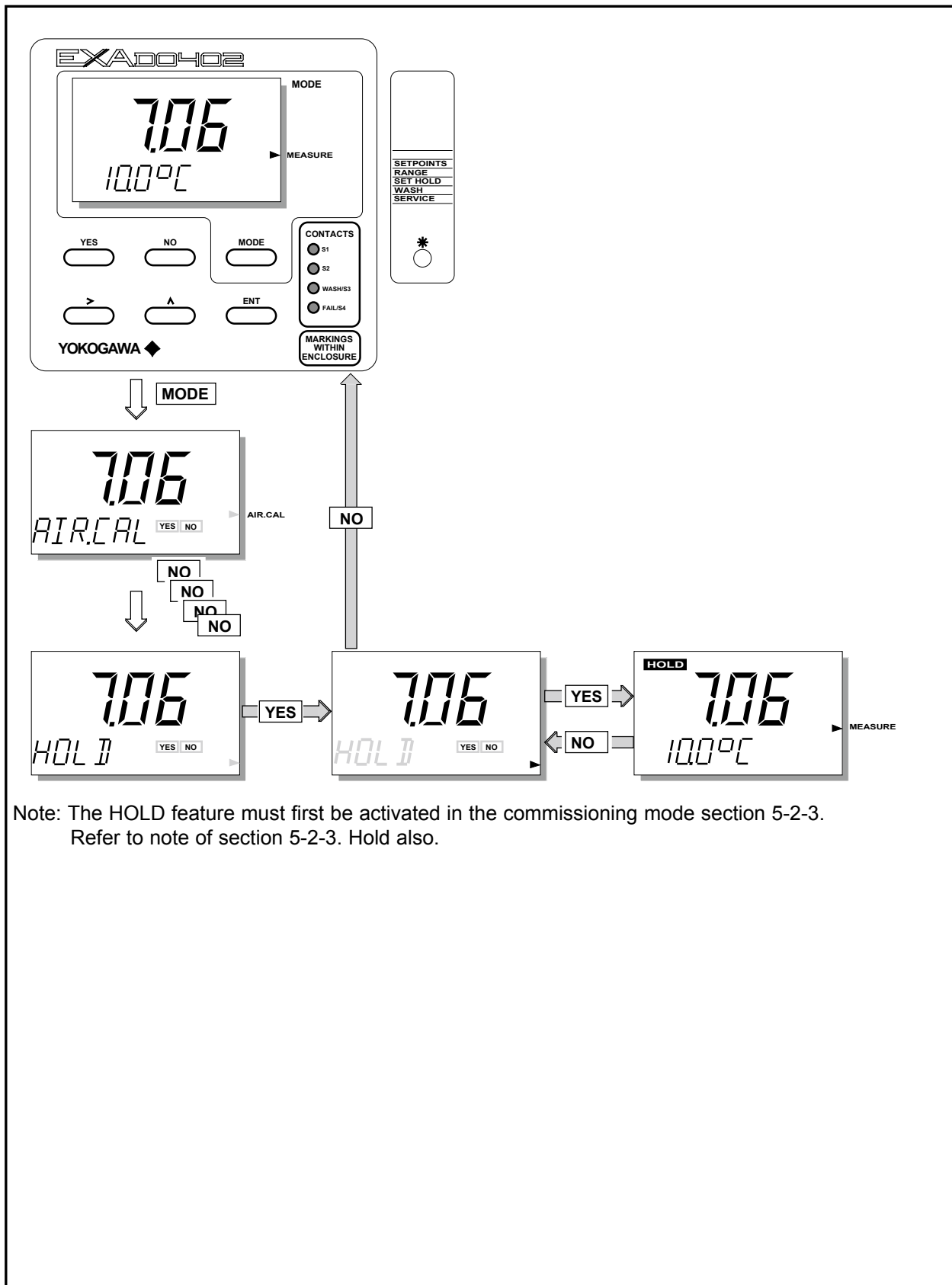
NOTE:

At this stage the user will be prompted for pass code where this has been previously set up in service code 52 in chapter 5.

Air calibration AIR.CAL	See “calibration” section 6.
H ₂ O calibration H2O.CAL	See “calibration” section 6.
Manual calibration MAN.CAL	See “calibration” section 6.
Display DISP	See “operation” section 4.
Setpoint SETP	Select and adjust setpoint (when enabled in service menu section 5, service code 51). See section 5-4 for adjustment procedure.
Wash WASH	Manually start/stop wash cleaning (when enabled in service menu section 5, service code 51). See section 5-3 for adjustment procedure.
Hold HOLD	Manually switch on/off HOLD (when enabled in commissioning menu section). See section 5-2 for adjustment procedure.
Manual temperature M.TEMP	Manually input a temperature value for a sensor without a temperature sensor (when enabled in service menu section 4, service code 13). See section 4-4 for adjustment procedure.
Manual pressure M.PRESS	Manually input a pressure value when the pressure sensor in the DO402G is not used (when enabled in service menu section 4, service code 51). See section 4-4 for adjustment procedure.

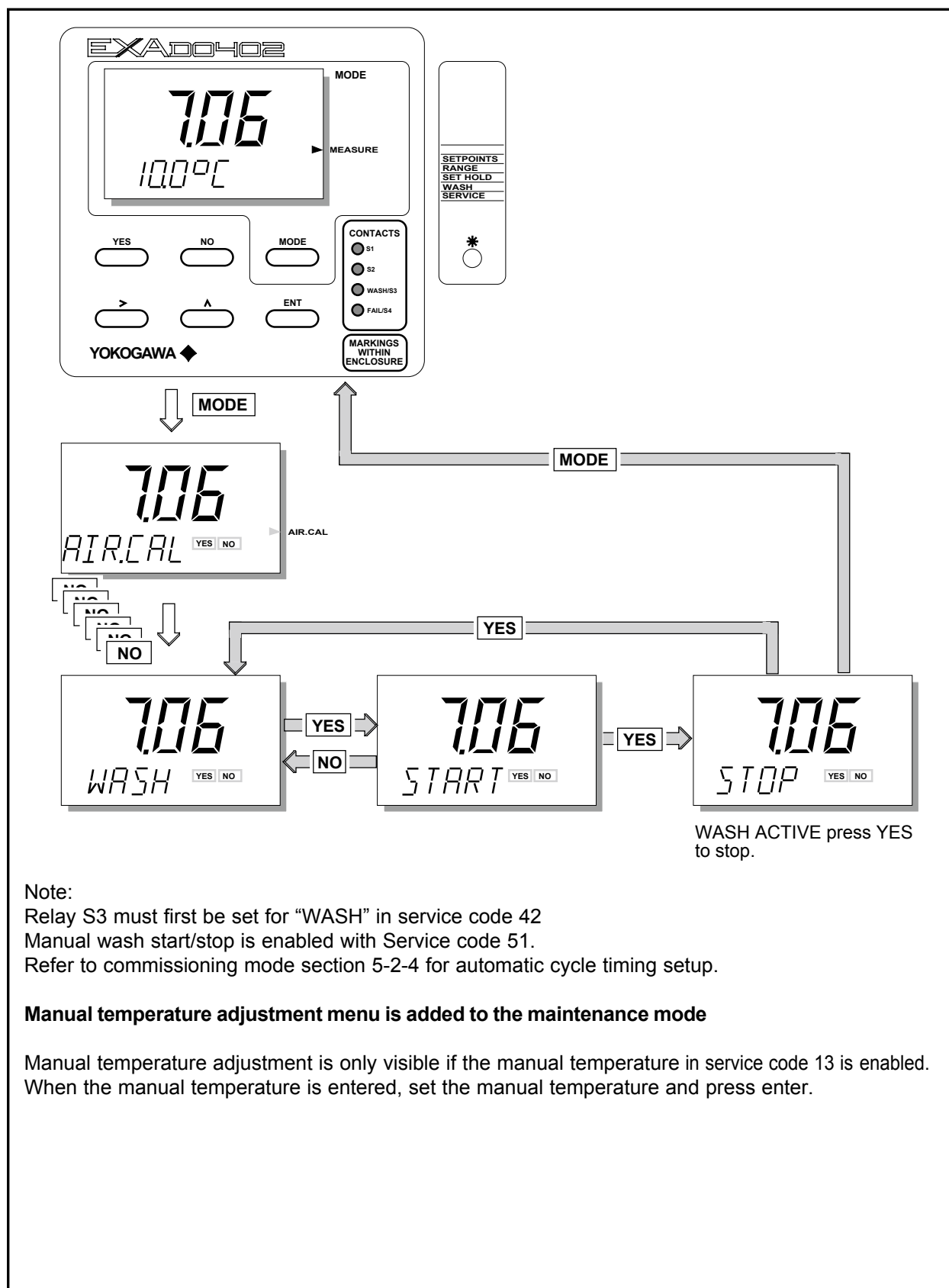
5-2 Parameter setting

5-1-1. Manual activation of Hold



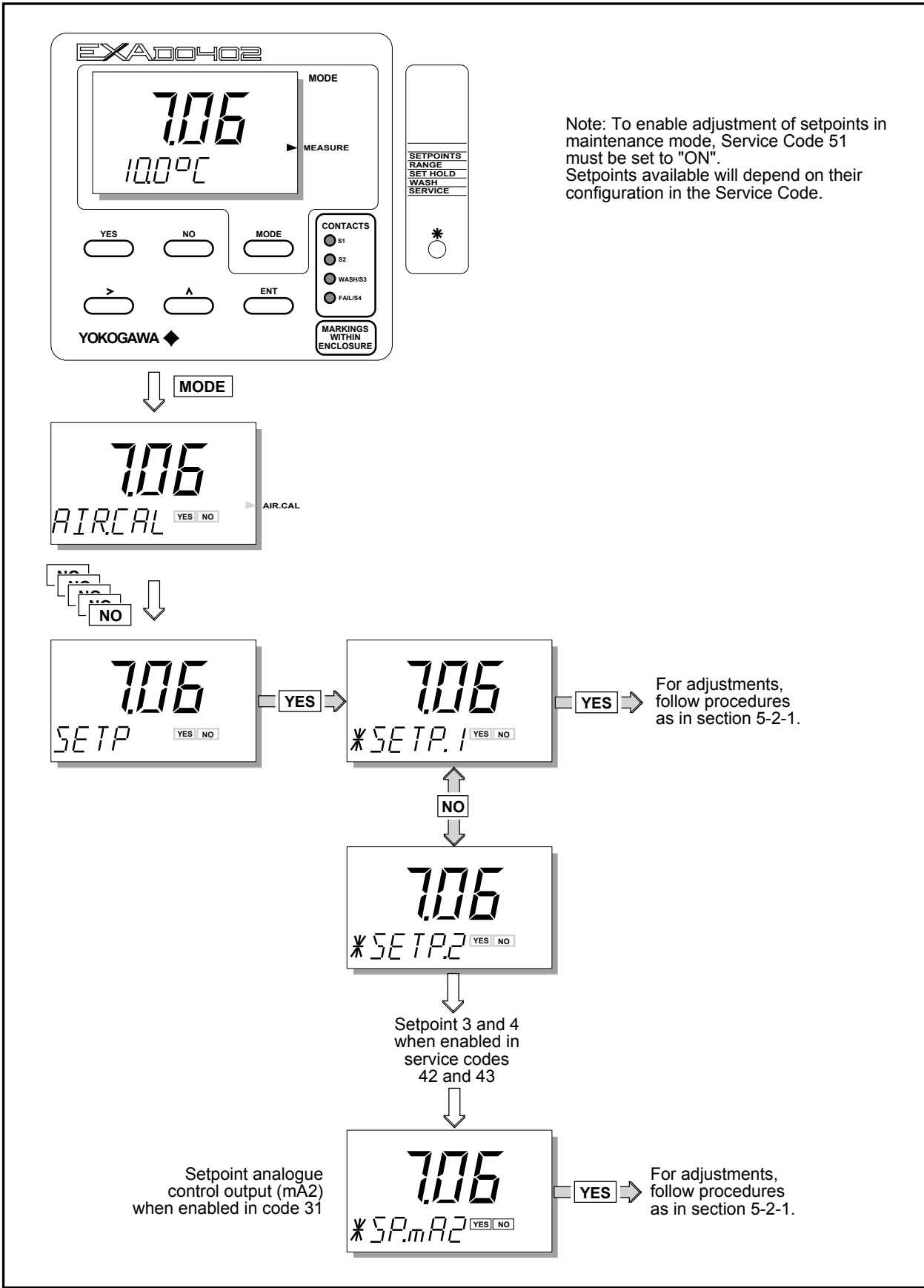
Note: The HOLD feature must first be activated in the commissioning mode section 5-2-3.
Refer to note of section 5-2-3. Hold also.

5-1-2. Manual Wash start/stop



5-4 Parameter setting

5-1-3. Setpoint adjustment



5-2. Commissioning mode

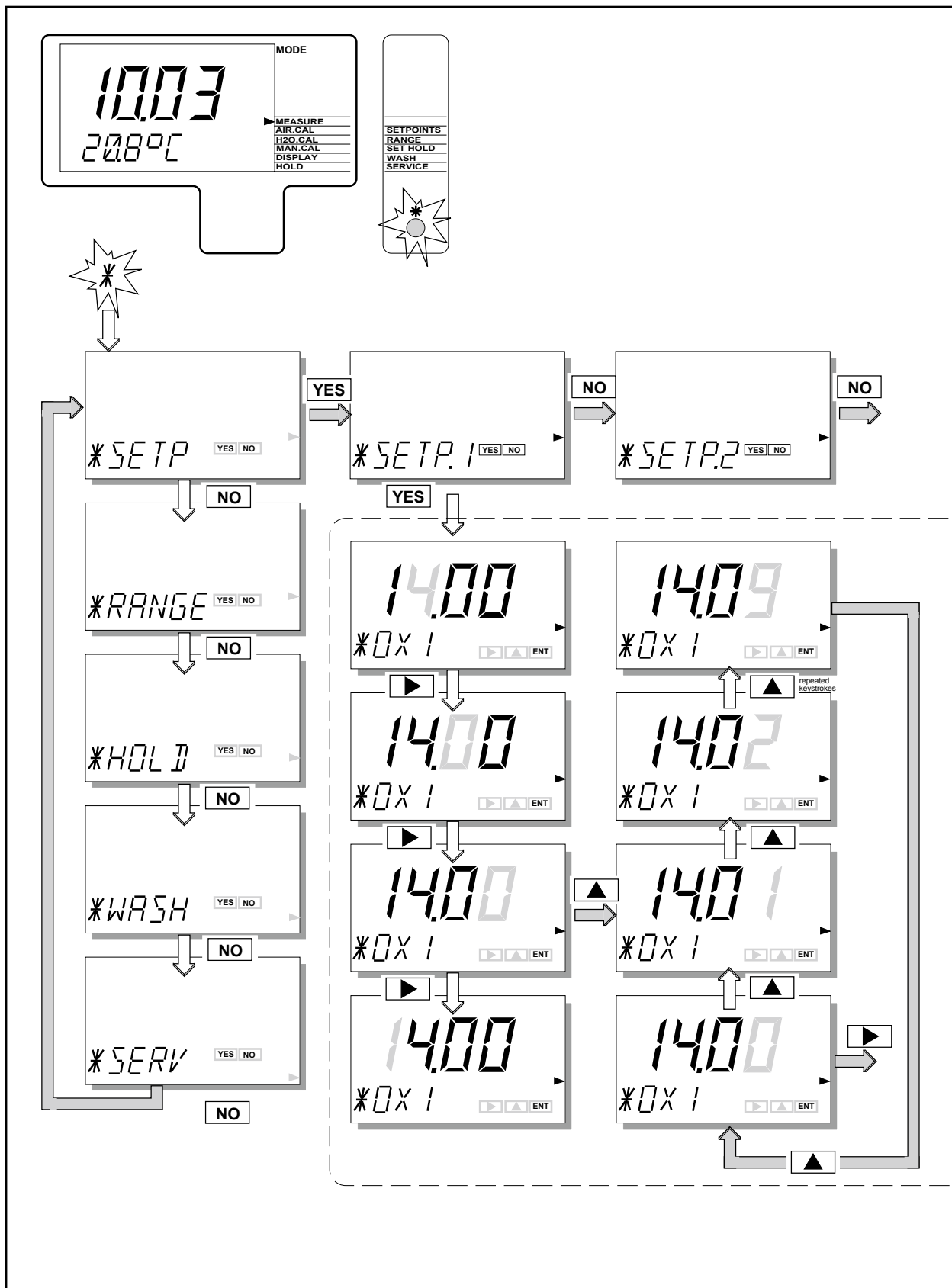
In order to obtain peak performance from the EXA converter, you must set it up for each custom application. Refer to section 1-4 for standard configurations and options.

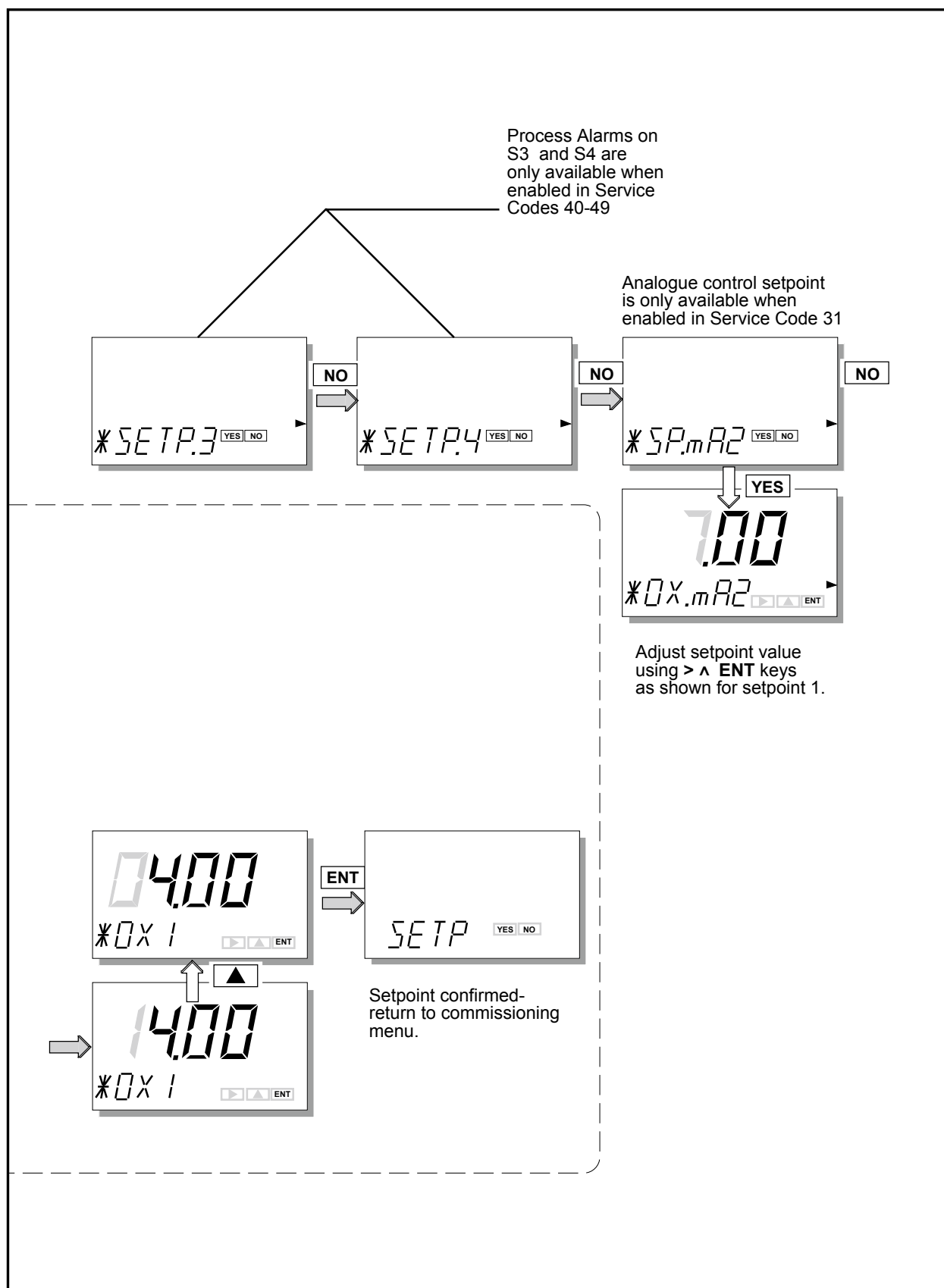
*SETP	Alarms are set by default	S1 - high process alarm S2 - low process alarm S3 - WASH S4 - FAIL
	The setpoints are at arbitrary default value. Therefore, you must set these to meaningful values, or set them to off. (See service codes 40 to 49 and user interface codes 50 to 59).	
*RANGE	mA output 1 is set as default to 0 - 20 mg/l mA output 2 is set as default to 0 - 50 °C	
	For enhanced resolution in more stable measuring processes, it may be desirable to select 0 - 5 mg/l range, for example, and maybe 0 - 25 °C temperature range. Service codes 30 to 39 can be used to choose other output parameters on mA output 2.	
*HOLD	The EXA converter has the ability to “hold” the output during maintenance periods. This parameter should be set up to hold the last measured value, or a fixed value to suit the process.	
*WASH	The EXA can be set up to control a wash cleaner. When using this function, the timings must be configured for interval, wash and recovery periods.	
*SERV	This selection provides access to the service menu.	

What follows are pictorial descriptions of typical frontplate pushbutton sequences for each parameter setting function. By following the simple YES/NO prompts and arrow keys, users can navigate through the process of setting range, setpoints, hold, wash and service functions.

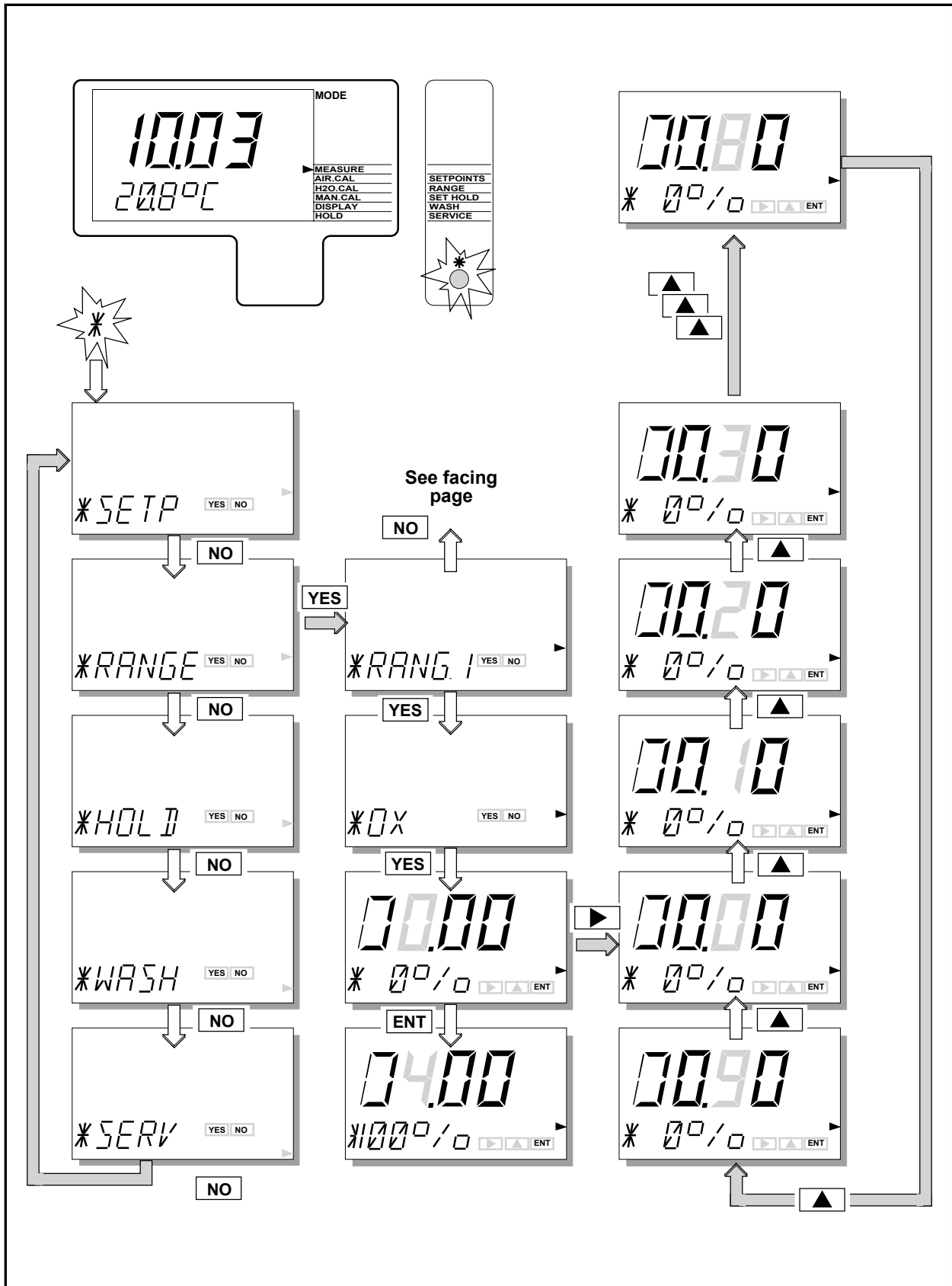
5-6 Parameter setting

5-2-1. Setpoints





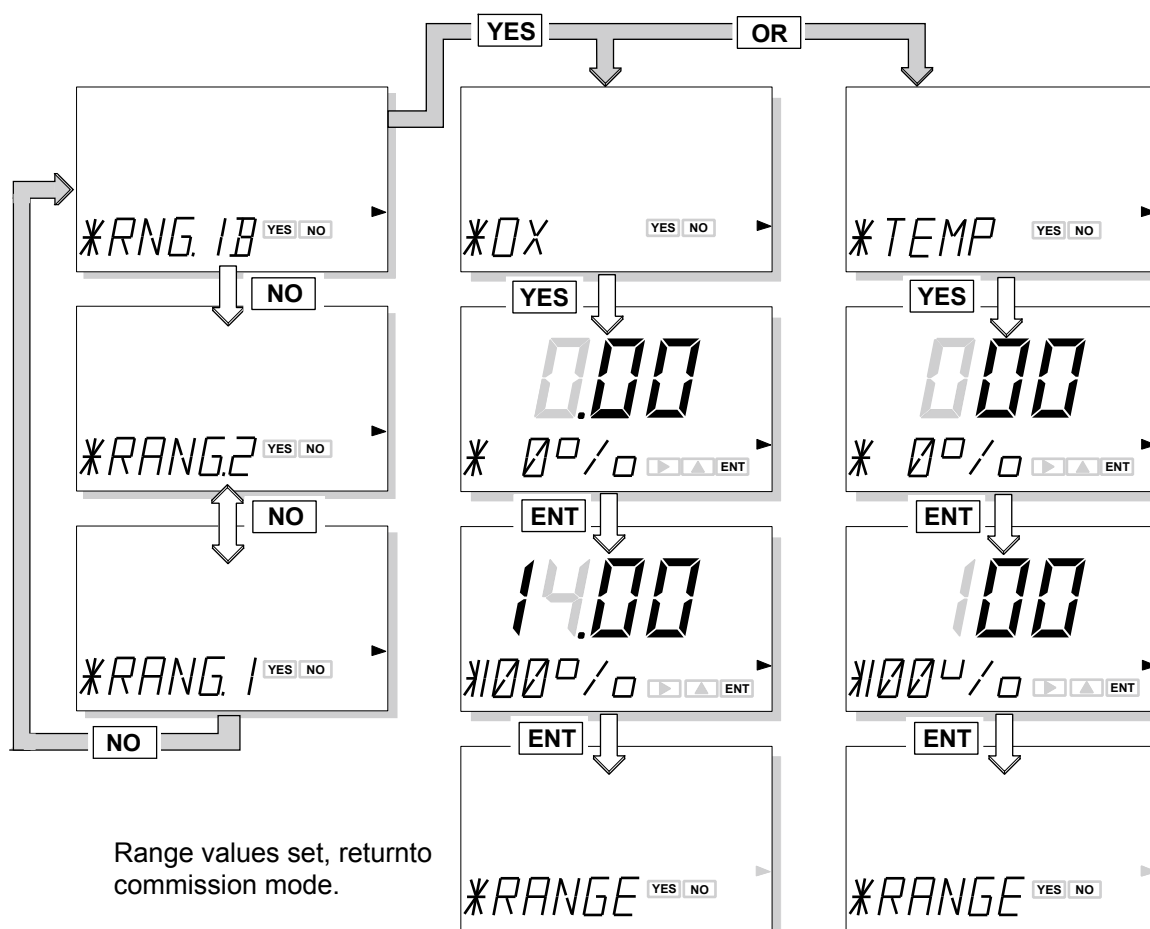
5-2-2. Range



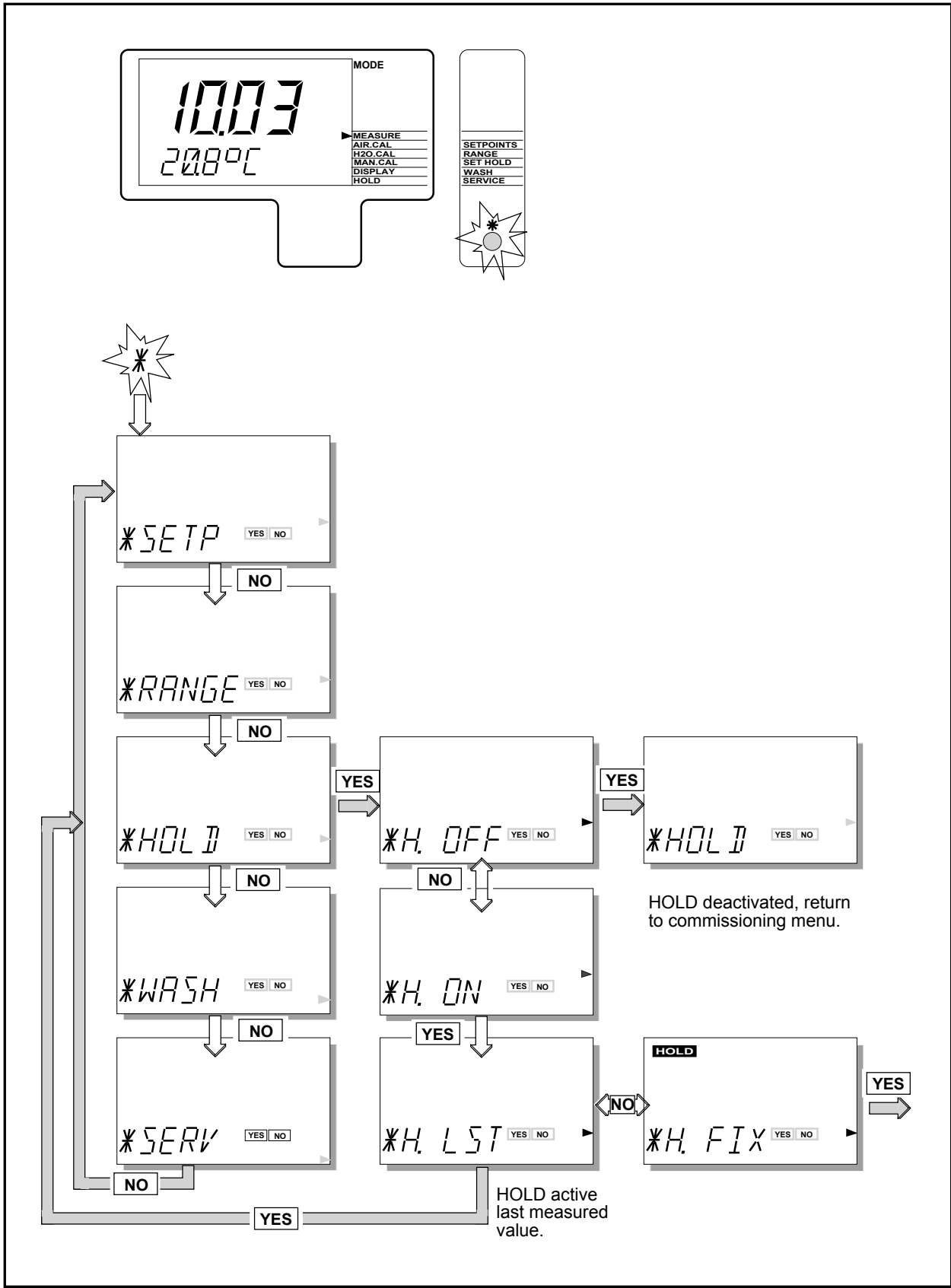
Choose Range to adjust, then set begin scale (0%) and end scale (100%) of the mA output signal, using the **>**, **^**, and **ENT** keys. Selection of mA output(0-20 / 4-20 mA) is in Service Code 30.

Note: Range 2 does not appear when PI control or table set on mA2

Range Selection Options are determined by Service Code 31

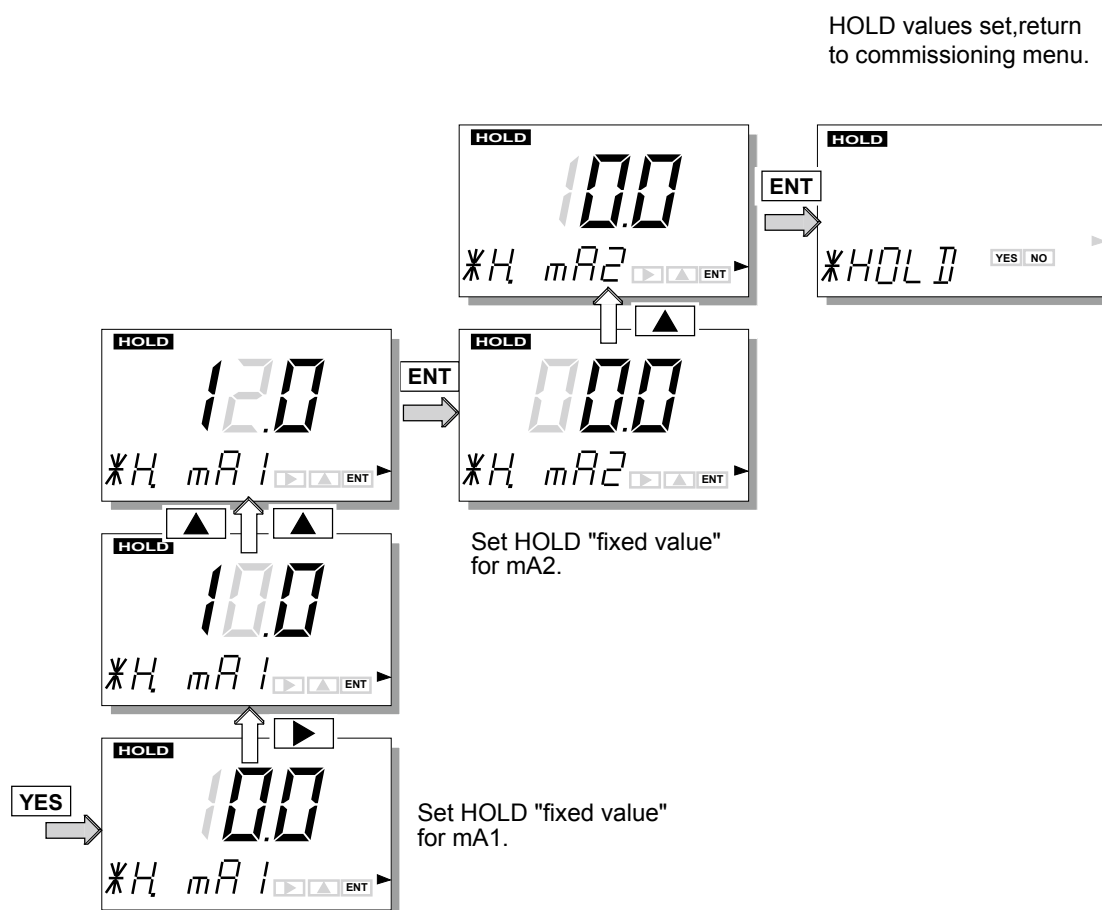


5-2-3. Hold

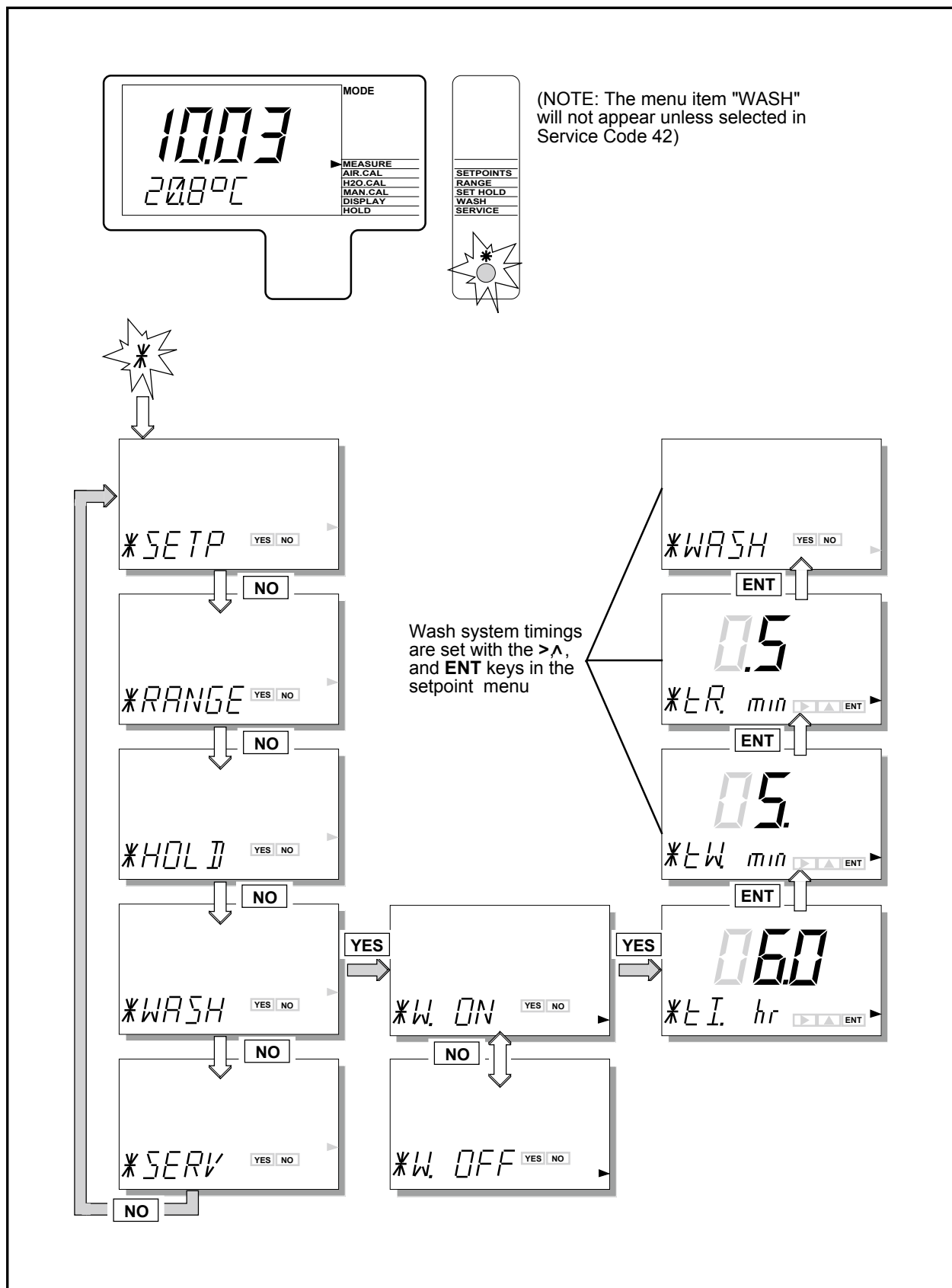


When using "wash" and activate HOLD for maintenance, "wash" should be OFF in the commissioning mode section 5-2-4. After that, "wash" should be ON again for returning to measurement mode.

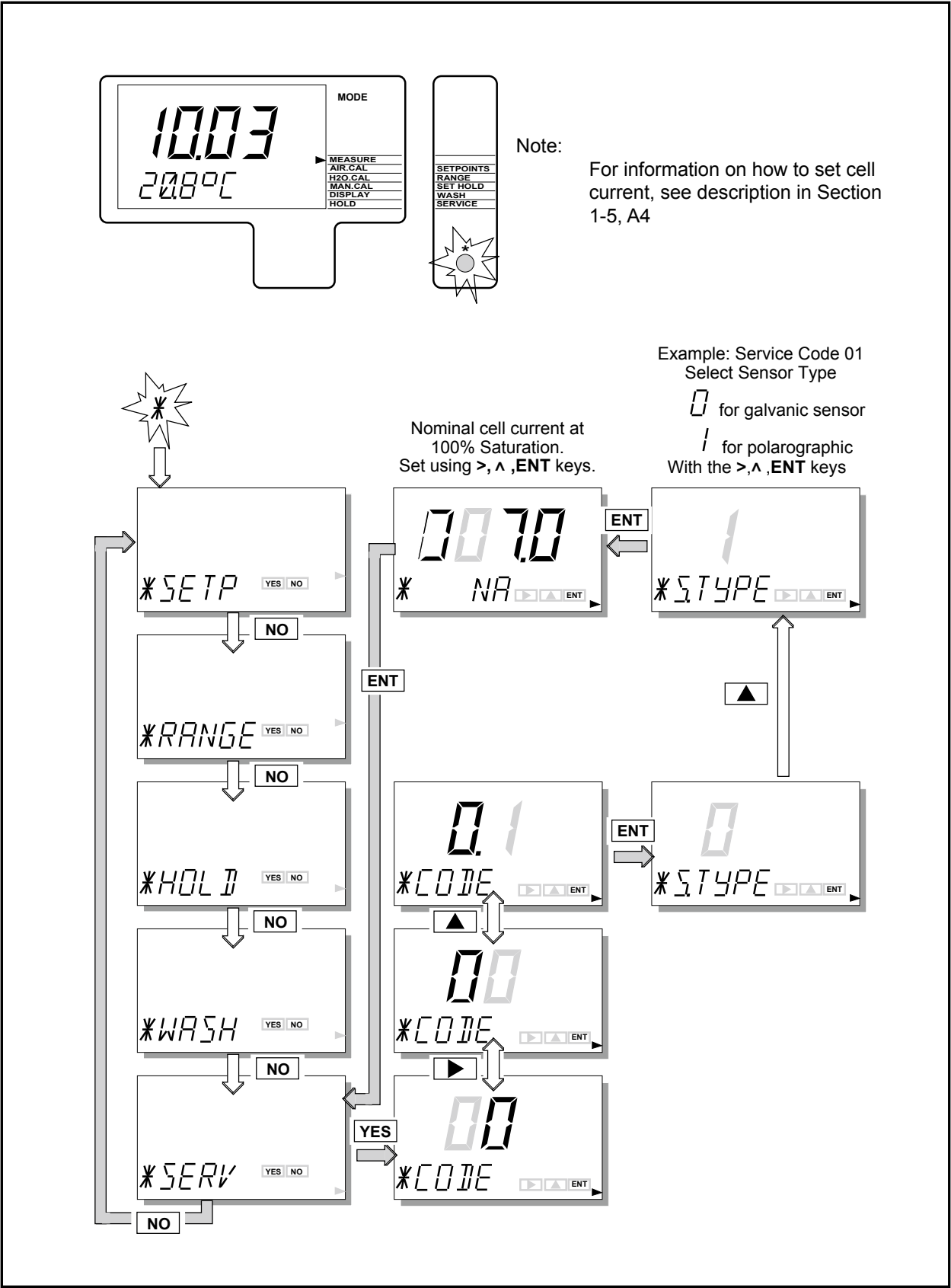
Note: HOLD will be non-activated at automatic wash cycle timing when "wash" is ON in the commissioning mode section 5-2-4.



5-2-4. Wash



5-2-5. Service



5-3. Notes for guidance in the use of service coded settings

5-3-1. Parameter specific functions

- Code 01 *S.TYPE Select 0 for DO30 sensor or other galvanic sensor. Select 1 for SM31, other polarographic sensor and optical dissolved oxygen sensor.
- *I.CELL After selecting sensortype you need to select the nominal cell current. With a galvanic sensor 3 choices are offered.
- Select 0 for DO30 thick (50 μm) membrane with a default of 3.75 μA .
 Select 1 for DO30 thin (25 μm) membrane with a default of 7.5 μA .
 Select 9 for user definable. This can be set to suit any galvanic sensor.
- With polarographic sensor 2 choices are offered.
 Select 0 for SM31 sensor with a nominal cell current of 50 nA.
 Select 9 for other polarographic sensor, with the nominal cell current to be user defined.

Select 9 for the DO70G sensor and input the nominal cell current of 60 nA.

General Note: Dissolved oxygen sensors fall into two categories – galvanic and polarographic. Yokogawa offer both types:

Settings for Yokogawa Sensors

	DO30	DO30	SM31.	DO70G
Membrane	Thick	Thin	Sterilizable	Fluorescence
*S.TYPE	0	0	1	1
* I.CELL	0	1	0	9

- Code 02 * CHECK This code is used to set up appropriate diagnostics. In most cases a zero calibration is not used, the default check, therefore, set to "off". When zero check enabled, the maximum permissible zero offset should be set as a signal current.
- When slope check enabled, the maximum as minimum calibrated slope values should be set as % of the nominal value.
- For the galvanic sensors, a membrane check can be enabled. This is an impedance test to ensure that the membrane is intact.
- The membrane check is not available for optical and polarographic sensors, so the membrane check cannot be enabled or disabled.

- Code 04 *SAL.TY Set 0 (salinity compensation disabled) when measuring water not including salinity components. Set 1 (salinity compensation enabled) when manually calibrated to salinity compensation. This is intended for accurately displaying saturated % concentration when measuring sample water. Set 1 (salinity compensation enabled) and then enter NaCl concentration using *[CL-]. For this concentration, enter salinity concentrations in actual sample water used to figure out salinity compensation values.

NOTE:

The instrument will not perform salinity compensation simply by setting the salinity compensation to "1" (enabled) in Code 04, but requires the NaCl concentration. For measurement in consideration of the salinity of a sample, first, manually calibrate with values corrected for salinity and enter the NaCl concentration in Code 04. (See Section 6.4, "Calibration method using manual calibration method")

Code	Display	Function	Function detail	X	Y	Z	Default values
Parameter Specific functions							
01	*S. TYPE	Sensor type	Galvanic	0			0
			Polarographic	1			
	*I.CELL	Sensor output Galvanic	3.75 μ A for 50 micron type	0			0
			7.50 μ A for 25 micron type	1			
			User defined	9			
	*I.CELL	Sensor output Polarographic	50 nA	0			0
			User defined	9			50 nA
02	*CHECK	Sensor check	Zero check: disabled	0			0.1.0
			Zero check: enabled	1			
			Slope check: disabled		0		
			Slope check: enabled		1		
			Membrane check: disabled/only for Galvanic			0	
			Membrane check: enabled/only for Galvanic			1	
	*ZERO	Maximum permissible Zero offset	0 to 19.99 μ A for Galvanic				0.5 μ A
			0 to 199.9 nA for Polarographic				5 nA
	*SL.MIN	Minimum calibrated slope	0 to 99.9%				40%
	*SL.MAX	Maximum calibrated slope	100 to 400%				200%
03	NOT USED		NOT USED				
04	*SAL.TY	Salinity comp.(*2)	Compensation disabled	0			0
			Compensation enabled	1			
	*[CL-]	NaCl conc.	Concentration in g/kg water: range 0.1 to 99.9 g/kg				Valid when code 04 is 1
05-09			Not used				

T0502.EPS

(*1): Membrane check can be enabled when galvanic sensor is selected and cannot be used unless the floating ball holder, PB350G or PB360G, is used.

(*2): The instrument will not perform salinity compensation simply by setting the salinity compensation to "1" (enabled) in Code 04, but requires the NaCl concentration. For measurement in consideration of the salinity of a sample, first, manually calibrate with values corrected for salinity and enter the NaCl concentration in Code 04. (See Section 6-4, "Calibration method using manual calibration method")

(*3): Set 60 nA for the DO70G optical dissolved oxygen sensor.

5-3-2. Temperature functions

Code 10	*T.SENS	Select temperature sensor to suit the measuring probe. Refer to instructions with DO sensor for which temperature sensor is used.
Code 11	*T.UNIT	Select °C or °F for temperature display.
Code 12	*T.ADJ	Adjust offset in temperature measurement when the sensor is at a stable known value.
Code 13	*T.MAN	Enable and set manual temperature compensation. After the manual temperature set menu has been displayed, enter temperature signals and press the [ENT] key to set. If the manual temperature compensation is enabled, the temperature set menu is displayed in maintenance mode.

The maximum and minimum slope values that may be entered depend on the nominal current from service code 01.

Example	: When nominal current = 3.75 µA the maximum and minimum slope calibration values that may be entered are:		
	Maximum	$3.75 \times 2 = 7.5 \mu\text{A}$	
	Minimum	$3.75 \times 0.4 = 1.5 \mu\text{A}$	

5-3-3. Calibration functions

Code 20	*ΔT.SEC	Set stability parameters for calibration. A greater time, and/or a smaller step gives
	*Δmg/l	greater stability before a calibration can be accepted. Use caution, however, to avoid very long calibration times.
Code 21	*0.CAL	In the DO30G sensor or other galvanic sensors and polarographic sensors, the zero point fluctuates less than the span. Therefore, with the zero check, a zero calibration is not required for these sensors provided that they are used in environments with high-concentration dissolved oxygen such as aerobic tanks. The zero calibration is recommended when installing sensors, replacing membranes, or performing measurement in anaerobic tanks with low-concentration dissolved oxygen. The two-point calibration (zero and span) is necessary for the DO70G optical dissolved oxygen sensor because of its operation principle. Select 1 to enable zero calibration. NOTE: The zero point is reset to the default when 0 is set (zero calibration disabled) even after calibration.
Code 22	*ZERO	Zero current values can be entered manually. If a zero calibration is made in maintenance mode, a zero current value will be automatically reset. NOTE: A zero current value is displayed only when a zero calibration is enabled in code 21.
	*SLOPE	Slope values can be manually entered with current values. If a span calibration is made in maintenance mode, slope values will be automatically reset. NOTE: Slope values can be displayed with current values. When span check functions are enabled in code 02, the above current values are converted to % values and compared with the set values. Slope % = current sensitive current /reference sensitive current

Code	Display	Function	Function detail	X	Y	Z	Default values
Temperature Measuring Functions							
10	*T.SENS	Temp. Comp.	Pt100 RTD	0			1
			Pt1000 RTD (DO30)	1			
			PB36 = 2k2 NTC	2			
			22k NTC (SM31) (DO70G)	3			
11	*T.UNIT	Temp units	Celsius	0			0
			Fahrenheit	1			
12	*T.ADJ	Temp adjust	Adjustment +/- 7.5 °C or +/- 13.5 °F				
13	*T.MAN	Manual TC	Automatic temperature comp	0			0
			Manual temp compensation	1			25 °C/ 77 °F
14-19			Not used				

Code	Display	Function	Function detail	X	Y	Z	Default values
Calibration Settings							
20	*ΔT.SEC *Δmg/l	Stabilization Step	Stabilisation time range 10- 600 s				60 s
			DO step change range 0-50 mg/l or 0-300 %				0.05 mg/l
21	*0.CAL	Zero cal.	Zero calibration disabled	0			0
			Zero Calibration enabled	1			
22	*ZERO	Zero entry	Galvanic: In case that zero check is activated in code 02 within *I.CELL value set in code 02 In case that zero check is not activated in code 02 ±19.99 µA				00.00 µA
			Polarographic: In case that zero check is activated in code 02 within *I.CELL value set in code 02 In case that zero check is not activated in code 02 ±199.9 nA				000.0 nA
	*SLOPE	Slope entry	Minimum setting (*I.CELL set in code 01) × (*SL.MIN set in code 02) Maximum setting (*I.CELL set in code 01) × (*SL.MAX set in code 02)				3.75 µA (50 nA)
23-29			Not used				

5-3-4. mA output settings

Code 30	*mA	Select 0-20 mA or 4-20 mA for each of the mA outputs.
Code 31	*OUTP.F	Select the parameter to be transmitted on each of the mA outputs.
	*D/R	Select the control action when PI selected on mA2. Direct action gives an increasing output with an increase in measured value.
Code 32	*BURN	Select "burn-out" signalling of diagnosed failures.
Code 33	*RGmA2	Set proportional band for PI control on mA2.
Code 34	*tImA2	Set integral time for PI control on mA2.
Code 35-36	*TABL1, *TABL2	Set up output linearization tables when selected in code 31.
Code 37	*DAMP	Set damping time to smooth out erratic process fluctuations.
Code 38	*SWTCH	After enabling range 1B, the user can set this range in commissioning mode. By pressing the external button with range 1B enabled, range 1B will be used instead of the normal range 1, until this button is not pressed anymore.

Code	Display	Function	Function detail	X	Y	Z	Default values
mA Output Functions							
30	*mA	mA output	Output 1 is 0- 20 mA	0			1.1
			Output 1 is 4- 20 mA	1			
			Output 2 is 0- 20 mA		0		
			Output 2 is 4-20 mA		1		
31	*OUTP.F	Output function	Process value on mA1	0			0.2
			Table on mA1	1			
			Process value on mA2		0		
			Table on mA2		1		
			Temperature on mA2		2		
	*D/R	Control action	PI control on mA2		3		0
			Reverse acting PI-control	0			
			Direct acting PI control	1			
32	*BURN	Burn-out	No burn-out function on mA1	0			0.0
			Burn low on fail on mA1	1			
			Burn high on fail on mA1	2			
			No burn out function on mA2		0		
			Burn low on fail on mA2		1		
			Burn high on fail on mA2		2		
33	*RGmA2	Prop. range	Proportional band: 0- 50 mg/l				5.0 mg/l
			0-300 % saturation				
34	*tlmA2	Integral time	Integral time in seconds 10 - 1999 s				100 s
35	*TABL1	Table for mA1	21 point table: Process value at				none
			0, 5, .. 100 % of span				
36	*TABL2	Table for mA2	21 point table: 0, 5, .. 100 %				none
37	*DAMP	Output damping	damping 0- 120 s				0 s
38	*SWTCH	Range 1B	Disabled	0			0
			Enabled	1			
39			Not used				

Note

To enable wash function, set Service Code 38 to 0, Service Code 42 to 4.0.0, and Service Code 51 to 0.1.0.

5-3-5. Contact outputs

Code 40, 41, 42 & 43	*S1 & *S2	Process relays can be set for a variety of alarm and control function.
		Digit "X" sets the type of trigger: Off means that the relay is not active Low setpoint means that the relay is triggered by a decreasing measurement. High setpoint means that the relay is triggered by an increasing measurement "HOLD" active means that there is maintenance activity in progress so the measurement is not live.
	For *S3	There is the extra possibility to set up for a wash controller.
	For *S4	There is the extra possibility to set up for "FAIL" indication.
		Digit "Y" sets the control action: Process alarm is a simple On/Off trip controlled by the high/low setpoint. Proportional duty cycle control has a pulse width modulation for proportional dosing with solenoid valves. Proportional frequency control is used for controlling electrically positioned valves. Temperature alarm is an On/Off trip on the measured temperature.
		Digit "Z" sets the control parameter: With or without "integral" action.

Code	Display	Function	Function detail	X	Y	Z	Default values
Contact Settings							
40	*S 1	Contact S1	Contact 1 inactive	0			2.0.0
			Low alarm configuration	1			
			High alarm configuration	2			
			Active during HOLD	3			
			Activation by process value		0		
			Proportional duty cycle		1		
			Proportional pulse frequency		2		
			Activation by temperature		3		
			PI control inactive			0	
			PI control active			1	
41	* S 2	Contact S2	Contact 2 inactive	0			1.0.0
			Low alarm configuration	1			
			High alarm configuration	2			
			Active during HOLD	3			
			Activation by process value		0		
			Proportional duty cycle		1		
			Proportional pulse frequency		2		
			Activation by temperature		3		
			PI control inactive			0	
			PI control active			1	
42	*S 3	Contact S3	Contact 3 inactive	0			4.0.0
			Low alarm configuration	1			
			High alarm configuration	2			
			Active during HOLD	3			
			Active during WASH	4			
			Activation by process value		0		
			Proportional duty cycle		1		
			Proportional pulse frequency		2		
			Activation by temperature		3		
			PI control inactive			0	
			PI control active			1	
43	*S 4	Contact S4	Contact 4 inactive	0			4.0.0
			Low alarm configuration	1			
			High alarm configuration	2			
			Active during HOLD	3			
			Active during FAIL	4			
			Activation by process value		0		
			Proportional duty cycle		1		
			Proportional pulse frequency		2		
			Activation by temperature		3		
			PI control inactive			0	
			PI control active			1	

5-22 Parameter setting

Code 44	*D.TIME	The delay time (or dead time) sets the minimum relay switching time. This function can be adjusted to give a good alarm function in a noisy process, preventing the relay from “chattering” or repeatedly switching when the signal is close to the setpoint.
	*P.HYST	The hysteresis is the value beyond the setpoint that the measured value must exceed before the control function will start working.
	*T.HYST	
Code 45	*RANGE	Proportional range is the value above (or below) the setpoint that generates full output in proportional control.
	*PER.	The time period of the overall pulse control cycle (one ON and one OFF period).
	*FREQ.	The maximum frequency for the pulse frequency control.
Code 46	*tI.CNT	The integral time for the PI control settings.
Code 47	*EXPIR	When a system is set up to control on the relay outputs, the expiry time can be enabled to warn of an ineffective control. In other words, when the setpoint is exceeded for more than 15 minutes an error message is generated. This can mean, for example, that the reagent tank is empty.

Code	Display	Function	Function detail	X	Y	Z	Default values
Contacts Settings							
44	*D.TIME	Dead Time	Delay after setpoint passed 0- 2.0 s				0.2 s
	*P.HYST	Hysteresis	Process value hysteresis 0-50 mg/l or 0-300 %				0.1 mg/l
	*T.HYST	Temp hyst	Temperature hysteresis 0- 5 °C (0- 12 °F)				0.5 °C
45	*RANGE	Prop. control	Proportional range 0- 50 mg/l				5.0 mg/l
	*PER.	Duty cycle	Period/ Duty cycle : 5- 100 s				10.0 s
	*FREQ.	Frequency	Frequency control 50 - 120 per min.				70 p.m.
46	*tl.CNT	Integral time	Int. time for contacts 10 - 1999 s				100 s
47	*EXPIR	Time out alarm	Disable time out alarm	0			0
			Enable time out alarm	1			
	*tE. mn		time out alarm after 0.5 - 199.9 min				15 min
48-49			Not used				

Control and Alarm Functions

Control output (mA)

- : PI control on the 2nd mA output.
The 2nd mA output can be configured to give a P/I (proportional and integral) control output.
The setpoint, proportional band and integral time are each fully programmable.
- Adjustable parameters
 - : Setpoint, proportional range and integral time.

Process alarm

- : The contact will be switched when the process value reaches a limit.
This can either be a high or low limit.
- Adjustable parameters
 - : Setpoint for the process value Hysteresis of the switching action Delay time of the relay (0 to 200 s)

PI duty cycle control (Fig. 1)

- : The contact is used to control the time a solenoid valve is opened.
The proportional control is achieved by opening and closing the solenoid valve and varying the ratio of on and off time (on, off).
- Adjustable parameters
 - : Setpoint, proportional range and integral time. Total period of the pulse period (5 to 100 s)

PI pulse frequency control (Fig. 2)

- : The contact is used to control a pulse-driven pump.
The frequency of pulses regulates the pump speed.
- Adjustable parameters
 - : Setpoint, proportional range & integral time. Maximum pulse frequency (50 to 120/min.)

Wash cleaning of sensors (Fig. 3)

- : Contact S3 is used to control the wash cycle, or as a process alarm.
- Adjustable parameters
 - : Cleaning time or washing time (tw) Recovery time after washing (tr) Interval time for wash cycle.
The graph shows a typical response curve during washing. The wash and recovery times need to be set to suit the process.

Fault alarm

- : Contact S4 by default set to function as an alarm, indicating that the EXA has found a fault in the measuring loop. If the self diagnostics of the EXA indicate a fault or error, the FAIL contact will be switched. In most cases this will be caused by a malfunction of the measuring loop.
The FAIL contact is also closed when the power is removed.
The "FAIL" contact may also be configured as a fourth process alarm.

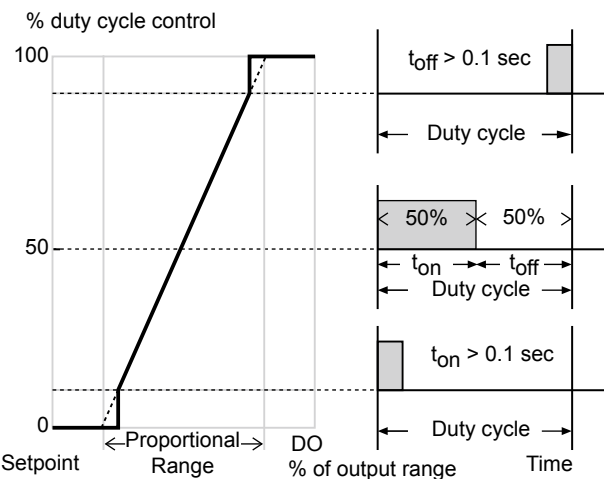


Figure 1. Duty cycle control

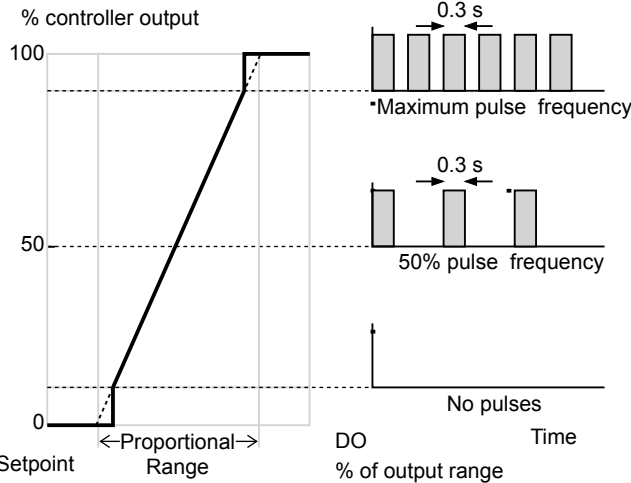


Figure 2. Pulse Frequency control

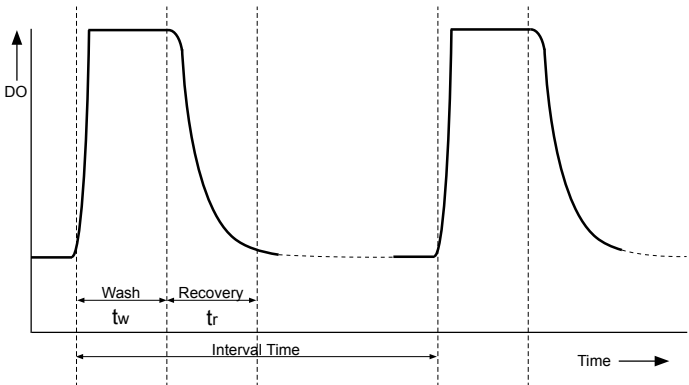


Figure 3. Dynamic response during wash

5-3-6. User interface

Code 50	*RET	When Auto return is enabled, the converter reverts to the measuring mode from anywhere in the configuration menus, when no button is pressed during the set time interval of 10 minutes.
Code 51	*MODE	The adjustment of the contact setpoints, and the manual operation of the wash system can be setup for operation in the maintenance mode. (Through the closed front cover). In maintenance mode the pressure can be entered (M. PRESS). If manual pressure is enabled, a warning is given when starting manual-, water and air calibration.
Code 52	*PASS	Passcodes can be set on any or all of the access levels, to restrict access to the instrument configuration.
Code 53	*Err.04	Error message configuration. Two different types of failure mode can be set. Hard fail gives a steady FAIL flag in the display, and a continuous contact closure. All the other contacts (controls) are inhibited (except HOLD contacts), and a Fail signal is transmitted on the outputs when enabled in code 32. Soft fail gives a flashing FAIL flag in the display, and the relay contacts are pulsed. The other contacts (controls) are still functional, and the controller continues to work normally. The call for maintenance is a good example of where a SOFT fail is useful. A warning that the regular maintenance is due, should not be used to shut down the whole measurement. An extra choice is added for Errors set to Soft Fail. It can be set to LCD + Fail contact (current situation) or to LCD only.
Code 54	*E12	Overrange alarm, set limit for supersaturation permissible before FAIL alarm is triggered.
Code 55	*CALL.M	Call for maintenance is a contact trigger to signal that the system has been in service for longer than the set time without calibration. The user can set up to 250 days as a routine service interval.
Code 56	*UNIT	Select mg/l, ppm or % saturation as the main unit, to suit the application.

Code	Display	Function	Function detail	X	Y	Z	Default values
User Interface							
50	*RET	Auto return	No return to meas. from HOLD	0			1
			Return to meas after 10 min	1			
51	*MODE	add. to MAINT	Setpoint adj. disabled	0			0.0.0
			Setpoint adj. also in MAINT	1			
			Wash start disabled		0		
			Wash start in maintenance mode		1		
			Manual pressure disabled			0	
			Manual pressure enabled			1	
52	*PASS	Password Pass: 111 for #=1, 333 for #=2, 777 for #=3, 888 for #=4, 123 for #=5, 957 for #=6, 331 for #=7, 546 for #=8, 847 for #=9	Direct access to MAINT	0			0.0.0
			MAINT protected by password	#			
			Direct access to COMM		0		
			COMM protected by password		#		
			Direct access to SERV			0	
			SERV protected by password			#	
53	*Err.01	Error setting	Response & Time failure Soft fail	0			1 Hard
			Response & Time failure Hard fail	1			
	*Err.02		Zero calibration Soft fail	0			1 Hard
			Zero calibration Hard fail	1			
	*Err.03		Slope calibration Soft fail	0			1 Hard
			Slope calibration Hard fail	1			
	*Err.04		Membrane failure Soft fail	0			1 Hard
			Membrane failure Hard fail	1			
	*Err.07		Temperature sensor open Soft fail	0			1 Hard
			Temperature sensor open Hard fail	1			
	*Err.08		Temp. sensor shorted Soft fail	0			1 Hard
			Temp. sensor shorted Hard fail	1			
	*Err.09		Cell current abnormal Soft fail	0			1 Hard
			Cell current abnormal Hard fail	1			
	*Err.12		Abnormal measured value Soft fail	0			1 Hard
			Abnormal measured value Hard fail	1			
	*Err.16		Cell for maintenance Soft fail	0			0 Soft
			interval time exceeded				
	*Err.22		Cell for maintenance Hard fail	1			
			interval time exceeded				
	*SOFT		Control time-out Soft fail	0			0 Soft
			Control time-out Hard fail	1			
54	*E12	overrange limit	LCD Fail Constant	0			0 LCD Fail
			LCD only	1			
54	*E12	overrange limit	E12 active at 0 - 300 % sat (Note)				150%
55	*CALL.M	E16 setting	No call for maintenance	0			0
			Call for maint. enabled	1			
			E16 message after 1- 250 days				30
56	*UNIT	PV unit	Unit of measurement mg/l	0			0
			Unit of measurement ppm	1			
			Unit of measurement % sat.	2			
57-59			Not used				

Note: For setting a value greater than 199.9, move the decimal point. For a value greater than 200%, decimal places cannot be used.

5-3-7. Communication setup

Code 60	*COMM. *SET. *ADDR.	The settings should be adjusted to suit the communicating device connected to the RS485 port. For the Yokogawa PC402 software package, the default settings match the software as shipped.
Code 61	*HOUR *MINUT *SECND *YEAR *MONTH *DAY	The clock/calendar for the logbook is set for current date and time as reference.
Code 62	*ERASE	Erase logbook function to clear the recorded data for a fresh start. This may be desirable when re-commissioning an instrument that has been out of service for a while.

5-3-8. General

Code 70	*LOAD	The load defaults code allows the instrument to be returned to the default set up with a single operation. This can be useful when wanting to change from one application to another.
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5-3-9. Test and setup mode

Code 80	*TEST	Not used
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Note:

Attempting to change data in service code 80 and above without the proper instructions and equipment, can result in corruption of the instrument setup, and will impair the performance of the unit.

Code	Display	Function	Function detail	X	Y	Z	Default values	
Communication								
60	*COMM.	Communication	Set communication Off	0			0.1	Off
			Set communication On	1				
			Communication write enable		0			write protect
			Communication write protect		1			
	*SET.	Baud rate & parity	Baud rate 1200	0			3.1	
			2400	1				
			4800	2				
			9600	3				9600
			Parity Off		0			
			Odd		1			Odd
			Even		2			
	*ADDR.	Network address	Set address 00 to 15				00	
61	*HOUR *MINUT *SECND *YEAR *MONTH *DAY	Clock setup	Adjust to current date and time using >, ^ and ENT keys					
62	*ERASE	Erase logbook	Press YES to clear logbook data					
63-69			Not used					

Code	Display	Function	Function detail	X	Y	Z	Default values	
General								
70	*LOAD	Load defaults	Reset configuration to default values					
71-79			Not used					

Code	Display	Function	Function detail	X	Y	Z	Default values	
Test and setup mode								
80	*TEST	Test and setup	Not used					

6. CALIBRATION PROCEDURE

Calibration of the dissolved oxygen analyzer is performed in the following situations:

- When a new dissolved oxygen sensor is installed.
- When the membrane is replaced and/or the electrolyte solution is replaced
- When the measuring error after cleaning exceeds the acceptable deviation from reference method
- When error message E12 or E16 indicates the need for maintenance

Note:

When a new sensor is installed, when the membrane is replaced, and/or the electrolyte solution is replaced, it may take some time for the electrodes to stabilize due to the initial electrolysis. In particular, a zero calibration should be performed after the electrodes are exposed to the air or immersed in sample water for about half a day. When the sensor cable terminals 13 and 15 are shorted together before installation, the time for the zero point to stabilize can be reduced.

Note:

It may take a long time for the electrodes to stabilize in the first electrolysis just after installing the DO30G sensor or other galvanic sensors and polarographic sensors, or after replacing the membrane or electrolyte solution. The zero calibration in particular should be carried out after leaving the sensor operating in air or measurement liquid for about half a day. The time for stabilizing the zero point can be reduced by shorting the terminals 13 and 15 of the sensor cable before installation.

6-1. General

6-1-1. Calibration methods

There are three methods for calibration of the EXA dissolved-oxygen analyzer: air calibration, water calibration and manual calibration.

Air calibration

This is the most common and easiest way to calibrate the analyzing system. The calibration is done in **AIR.CAL** mode in maintenance level.

Water calibration

This is the traditional way to calibrate dissolved oxygen analyzers in laboratory environment. Accurate results can be obtained if the calibration is performed carefully. The water calibration may include a zero calibration if so selected in service code 21. Normally only a zero check is performed without calibration, since a good sensor has no zero signal.

Always select 1 in service code 21 for the DO70G optical dissolved oxygen sensor.

Water calibration is not possible in salt water unless salinity compensation is activated in service code 04. The calibration is done in **H2O.CAL** mode in maintenance level.

Note:

In normal industrial environment better results are obtained with air calibration, which is therefore the recommended method.

Manual calibration

This is a calibration method whereby the sensor is not exposed to a calibration fluid, but is calibrated by comparison with a reference method. This reference method is normally a laboratory analysis of the water sample: either by iodometric titration according ISO 5813 or an electrochemical method according ISO 5814.

The calibration is done in **MAN.CAL** mode in maintenance level.

Note:

Calibration must be carried out after changing the manual pressure setting (see service code 51).

When the manual pressure is enabled, air and water calibrations are made based on the specified pressure. M.PR.ON YES/NO is displayed before the calibration to confirm whether the calibration will be made based on the pressure.

6-2 Calibration

6-1-2. Diagnostic functions performed during calibration

The calibration is a semi-automatic calibration, which means that the sensor output is used for calculation of sensor parameters after the readings have stabilized. The criteria for stabilization are set in service code 20. If stable readings are not achieved within one hour error E1 message will appear on the display and the procedure is aborted. The calculated sensor parameters are compared with preset tolerances and if these conditions are not met, Error E2 (Zero Error) or E3 (Slope Error) will be signalled.

- Notes:**
1. Error messages that appear initially indicate inadequate settings of the diagnostic variables in service codes 01, 20 and/or 22.
 2. Patience improves the accuracy of calibration. When the EXA prompts the user that the preset criteria are met by showing **CAL.END** message it only means that the minimum criteria are met. When the signal still changes after this initial acceptance, EXA will automatically update the sensor characteristics with the new information.

6-2. Calibration procedure using air calibration method

6-2-1. Preparation

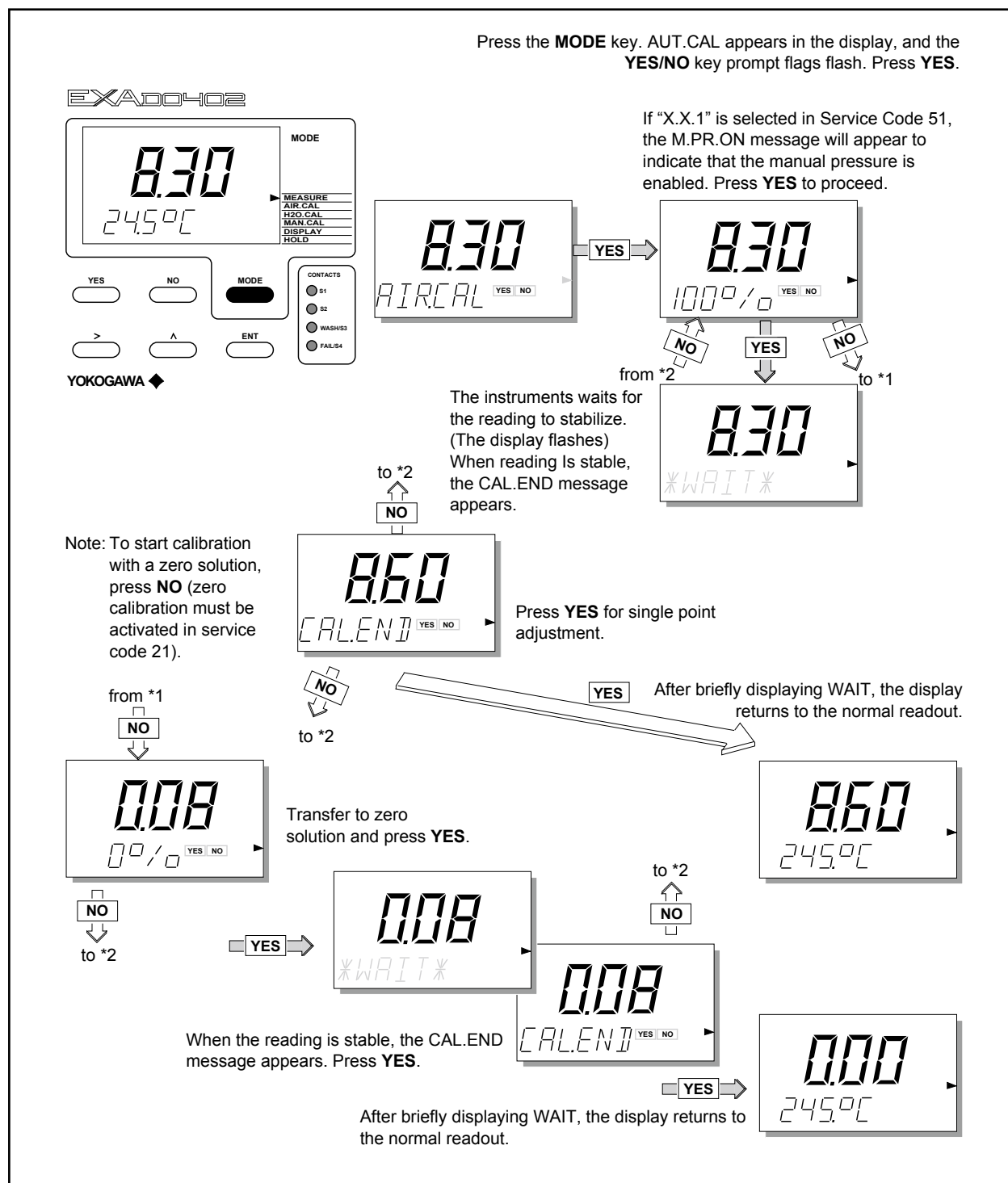
Move the sensor to a maintenance site and wash off any dirt on the membrane. Lightly wipe off any remaining water from the membrane with a soft tissue.

Expose the sensor to the air in an environment where there is no temperature change and no wind. (A convenient way to accomplish this environment is to place the sensor in an empty bucket)

Note: If sensors are used without temperature compensating element, the temperature must be adjusted to ambient temperature in service code 13.

Before zero calibration, see 6-3-1 Preparation

6-2-2. Procedure for air calibration



6-3. Calibration procedure using water calibration method

6-3-1. Preparation

Move the sensor to a maintenance site and wash off any dirt on the membrane. Lightly wipe off any remaining water from the membrane with a soft tissue.

Prepare the necessary equipment and reagents to be used for the span and (if required) zero calibration.

Equipment for span calibration includes:

- beaker or bucket
- magnetic stirrer or other means of agitating the water
- Demineralized water or salty process water if salinity compensation is activated
- Air supply pump (aquarium pump)
- Glass diffuser to generate small air bubbles

NOTE:

It takes 15 to 30 minutes of aeration before it can be assumed that the water is fully saturated with air.

Reagent for zero calibration:

- Sodium sulfite
- demineralized water

The zero oxygen solution contains approximately 50 grams of sodium sulfite per liter.

6-3-2. Calibration operation (water calibration method)

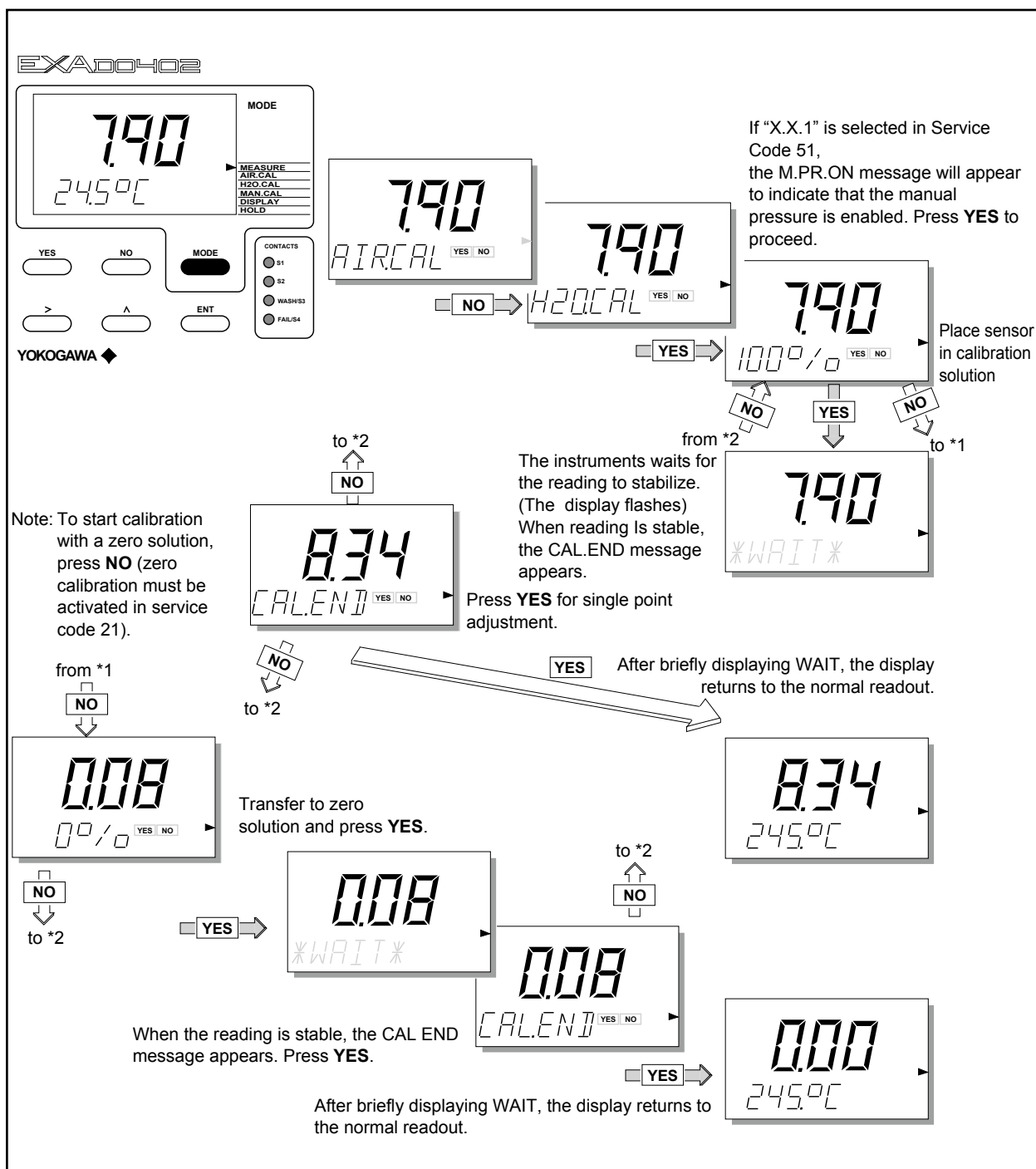
If both zero and span calibration are used, it is better to start with span calibration in spite of normal calibration sequence with analog instrumentation. Otherwise the sensor must be rinsed off carefully to prevent ingress of oxygen absorbing sulfite in the aerated water.

NOTE:

It takes a long time to calibrate the DO30G sensor or other galvanic sensors and polarographic sensors with sulfite-saturated water. Even after CAL.END is displayed, wait 40 to 50 minutes and then press the YES key. If the YES key is pressed without waiting, the indicator may show a minus reading during measurement. In an aerobic tank with high dissolved oxygen concentrations, a zero calibration is not required if a zero check is performed, because the indicating error is so insignificant that it does not affect the measurement results. There will be no problem if the electrodes are immersed in a zero solution for about 10 minutes and the indication falls below 1 mg/l. However, it is recommended to wait for about 60 minutes before performing a zero calibration when a new sensor is installed, when the membrane is replaced, or in a place where dissolved oxygen concentrations are low, such as in an anaerobic tank. If the solubility does not fall below 1 mg/l even after waiting for about 10 minutes, remove the sensor and clean it, and replace the membrane and/or replace the electrolyte solution.

Calibration may take longer than 10 minutes. Before starting the calibration procedure, check the setting of Auto Return (*RET.) in Service Code 50. It is recommended to set the Auto Return to "0" (No return to meas. from HOLD). After the calibration procedure has been completed, set the Auto Return to the desired setting in Service Code 50.

6-3-3. Procedure for Water calibration



6-4. Calibration method using manual calibration method

6-4-1. Preparation

a. Cleaning

Confirm that the readings of the analyzer are stable and measured with a clean sensor.

Otherwise move the sensor to a maintenance site and wash off any dirt on the sensor membrane. Move the sensor back to the process water and wait for the readings to stabilize.

b. Sampling

The manual calibration procedure involves adjustment of the readings to a reference standard. Normally this reference is a laboratory measurement that analyses a sample that must be identical to the sample measured with the on-line analyzer.

The following precautions must be taken into account:

- The sample must be analyzed directly after sampling to avoid change of dissolved oxygen concentration or temperature after sampling.
- The reference standard must be analyzed with a laboratory meter that is calibrated prior to sample analysis.
- The reference method must be calibrated with the same calibration data as specified in ISO 5814 to avoid discrepancies.

Most important calibration data are:

Dissolved oxygen concentration at saturation conditions as function of temperature, barometric pressure, altitude and salinity.

These data are included in this manual for reference and verification of correct calibration of reference analyzers. DO402G has taken all these variables into account during the semi-automatic calibration methods.

c. Compensating the salinity of a sample.

Example of procedure for (salinity compensation) calibration.

When performed in consideration of the salinity, calibration should be done manually.

The following shows a procedure for salinity compensation. Perform the calibration referring to Table 6.1.

Assuming that the atmosphere is 1 atm, the solution temperature is 22.5 °C, and the salinity is 30 g/kg (3 wt % seawater equivalent):

1. Calculating the saturated concentration of water

According to Table 6.1, the solubility is 8.74 mg/l at 22 °C and 8.58 mg/l at 23 °C.

The solubility at 22.5 °C is calculated as follows:

$$8.74 + (8.58 - 8.74) \times (22.5 - 22) = 8.66 \text{ mg/l}$$

2. Calculating the value corrected for salinity

$$0.0453 + (0.0443 - 0.0453) \times (22.5 - 22) = 0.0448 \text{ mg/l}$$

$$0.0448 \times 30 = 1.34 \text{ mg/l}$$

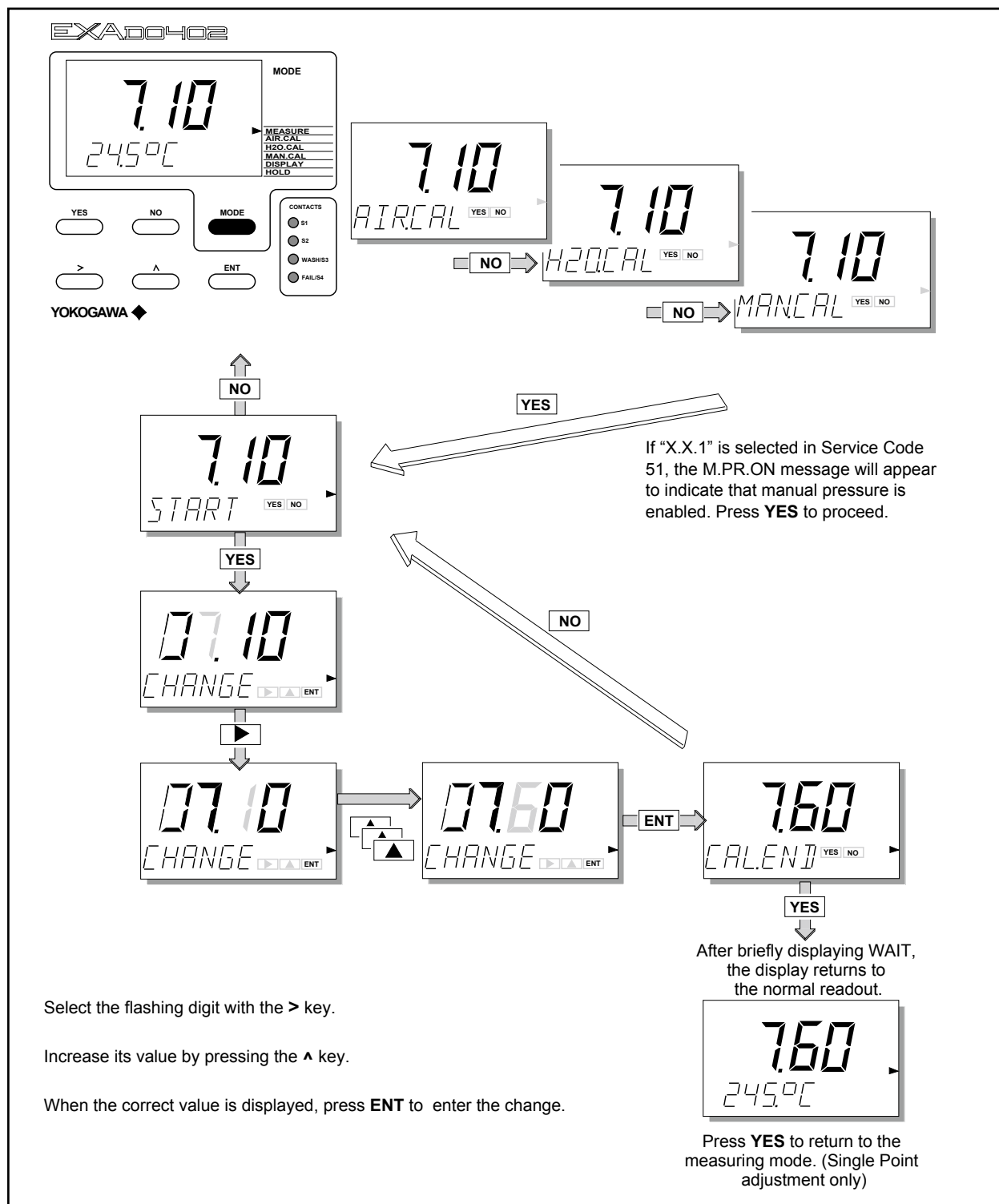
3. Calculating the saturated concentration of solution (to be calibrated)

$$8.66 - 1.34 = 7.32 \text{ mg/l}$$

NOTE:

When salinity compensation is done, salinity compensation must be enabled in Service Code 04 to allow the instrument to show the saturated concentration (%) during sample measurements correctly.

6-4-2. Procedure for manual calibration



6-8 Calibration

Table 6-1. Solubility of oxygen (mg/l) in water as a function of temperature & salinity

Temp	Solubility of oxygen in water in equilibrium with air @101.325kPa[pO ₂]	Correction to be subtracted for each degree of salinity expressed in grams per kilogram of total salts in water [ΔpO ₂]
°C	mg/l	mg/l
0	14.62	0.0875
1	14.22	0.0843
2	13.83	0.0818
3	13.46	0.0789
4	13.11	0.0760
5	12.77	0.0739
6	12.45	0.0714
7	12.14	0.0693
8	11.84	0.0671
9	11.56	0.0650
10	11.29	0.0632
11	11.03	0.0614
12	10.78	0.0593
13	10.54	0.0582
14	10.31	0.0561
15	10.08	0.0545
16	9.87	0.0532
17	9.66	0.0514
18	9.47	0.0500
19	9.28	0.0489
20	9.09	0.0475
21	8.91	0.0464
22	8.74	0.0453
23	8.58	0.0443
24	8.42	0.0432
25	8.26	0.0421
26	8.11	0.0407
27	7.97	0.0400
28	7.83	0.0389
29	7.69	0.0382
30	7.56	0.0371

Table 6-2. Solubility of oxygen (mg/l) at various temperatures and elevations (based on sea level barometric pressure of 760 mm Hg)

Temp °C	Elevation (metres above sea level)						
	0	300	600	900	1200	1500	1800
0	14.6	14.1	13.6	13.2	12.7	12.3	11.8
2	13.8	13.3	12.9	12.4	12.0	11.6	11.2
4	13.1	12.7	12.2	11.9	11.4	11.0	10.6
6	12.4	12.0	11.6	11.2	10.8	10.4	10.1
8	11.8	11.4	11.0	10.6	10.3	9.9	9.6
10	11.3	10.9	10.5	10.2	9.8	9.5	9.2
12	10.8	10.4	10.1	9.7	9.4	9.1	8.8
14	10.3	9.9	9.6	9.3	9.0	8.7	8.3
16	9.9	9.5	9.2	8.9	8.6	8.3	8.0
18	9.5	9.2	8.9	8.6	8.3	8.0	7.7
20	9.1	8.8	8.5	8.2	7.9	7.7	7.4
22	8.7	8.4	8.1	7.8	7.6	7.3	7.1
24	8.4	8.1	7.8	7.6	7.3	7.1	6.8
26	8.1	7.8	7.6	7.3	7.0	6.8	6.6
28	7.8	7.5	7.3	7.0	6.8	6.6	6.3
30	7.5	7.2	7.0	6.8	6.5	6.3	6.1
32	7.3	7.1	6.8	6.6	6.4	6.1	5.9
34	7.1	6.9	6.6	6.4	6.2	6.0	5.8
36	6.8	6.6	6.3	6.1	5.9	5.7	5.5
38	6.6	6.4	6.2	5.9	5.7	5.6	5.4
40	6.4	6.2	6.0	5.8	5.6	5.4	5.2

Table 6-3. Solubility of oxygen (mg/l) of sea water & fresh water (based on sea level barometric pressure of 760 mm Hg)

Temp °C	Solubility	
	Seawater mg/l	Fresh water mg/l
0	11.97	14.62
2	11.36	13.84
4	10.82	13.13
6	10.29	12.48
8	9.84	11.87
10	9.43	11.33
12	9.05	10.83
14	8.69	10.37
16	8.37	9.95
18	8.06	9.54
20	7.77	9.17
22	1.48	8.83
24	7.21	8.53
26	6.93	8.22
28	6.67	7.92
30	6.41	7.63

7. MAINTENANCE

It is important for maintaining the measurement accuracy of the EXA DO series of wire dissolved-oxygen metering system to perform inspection and maintenance at fixed intervals. It also serves to prevent problems from arising.

This chapter describes daily inspection and maintenance for the purpose of maintaining system performance.

7-1. Overall dissolved oxygen metering system

Tables 7-1 and 7-2 show the inspection and maintenance items for equipment composing 4-wire dissolved-oxygen metering system. The procedure of inspection and maintenance for the dissolved oxygen converter is described in Section 7-2. For inspection and maintenance of the sensors and holders, see each user's manual respectively.

7-1-1. Inspection and maintenance to be implemented periodically

Table 7-1 shows the items which are recommended to be inspected and maintained periodically.

Table 7-1. Items for periodic inspection and maintenance of 4-wire dissolved-oxygen metering system

Instrument or apparatus	Item	Recommended Interval
All equipment	a. Calibration	a. 1 to 2 months
Dissolved oxygen sensor	a. Clean the tip of the sensor b. Polishing of (silver) electrode surface and replacement of electrolyte c. Replacement of membrane assembly d. Replacement of sensor cap	a. 1 to 2 months b. 6 to 8 months c. 6 to 8 months d. 6 to 12 months
Dissolved oxygen converter	a. Inspection of temperature indication (error check) b. Replacement of fuse	a. 6 months b. 1 to 2 years
Float holder	a. Sweeping of winch mechanism	a. (depends on installation environment)
Immersion holder	a. Inspection of sensor holding O-ring b. Sweeping of cleaner nozzle c. Inspection for leakage from the solenoid valve for cleaning utility	a. 6 months b. 1 to 2 months c. 6 months

7-1-2. Inspection and maintenance to be implemented on occasion

Occasionally implement the maintenance that is not directly related to measurement functions and maintenance associated with errors.

Table 7-2. Items for occasional inspection and maintenance of 4-wire dissolved-oxygen metering

Faulty phenomenon	System content of inspection
Error E2 occurrence	Check whether the dissolved-oxygen sensor membrane is contaminated or not. Check whether the nozzle is clogged or not.
Error E3 occurrence	Polish the silver electrode surface of the galvanic dissolved-oxygen sensor, platinum surface of the polarographic dissolved-oxygen sensor, and replace the electrolyte. Check that the connection between sensor and sensor cable is fit, and LED emission of the optical dissolved-oxygen sensor.
It is difficult to see the inside of the converter through the window	Wipe off the dirt on the transparent window using tissue paper or the like. (Use detergent for hard-to-clean dirt.)

7-2. Periodic maintenance for the EXA DO402G converter

The DO402G converter requires very little periodic maintenance. The housing is sealed to IP65 (NEMA 4X) standards, and remains closed in normal operation. Users are required only to make sure the front window is kept clean in order to permit a clear view of the display and allow proper operation of the pushbuttons. If the window becomes soiled, clean it using a soft damp cloth or soft tissue. To deal with more stubborn stains, a neutral detergent may be used.

NOTE:

Never use harsh chemicals or solvents. In the event that the window becomes heavily stained or scratched, refer to the parts list (Chapter 9) for replacement part numbers.

When you must open the front cover and/or glands, make sure that the seals are clean and correctly fitted when the unit is reassembled in order to maintain the housing's weatherproof integrity against water and water vapor. The DO measurement uses small signal currents and may otherwise be prone to problems caused by exposure of the circuitry to condensation.

7-3. Fuse Replacement

This section describes how to replace the power supply fuse.



DANGER

- Use only a fuse of the specified current, voltage and type ratings to prevent fire.
- Power to the instrument must be turned off at the external breaker before replacing the fuse. After replacing the fuse, install a high-voltage shield plate before turning the power on.
- Do not short circuit the fuse holder.

Specified Ratings of the Power Supply Fuse

The power supply fuse (recommended fuse) used in the DO402G is as follows.

- 100/115 V AC version
 - Maximum rated voltage: 250 V
 - Maximum rated current: 200 mA
 - Compliance: UL, CSA, VDE, Japan's Electrical Appliance and material Safety Law
 - Part number: A1105EF
- 230 V AC version
 - Maximum rated voltage: 250 V
 - Maximum rated current: 100 mA
 - Compliance: UL, CSA, VDE, Japan's Electrical Appliance and material Safety Law
 - Part number: A1103EF

How to replace the fuse

- 1) Before replacing the fuse, turn off power to the instrument at the external breaker.
- 2) Remove the instrument cover and the high-voltage shield plate.
- 3) Remove the cover from the fuse holder by pulling out by hand.
- 4) Remove the fuse and install a new, recommended or equivalent fuse on the holder.
- 5) Put the fuse cover back on the holder securely.
- 6) Install the high-voltage shield plate.

It is recommended that the fuse be replaced every two years even if it has not blown.

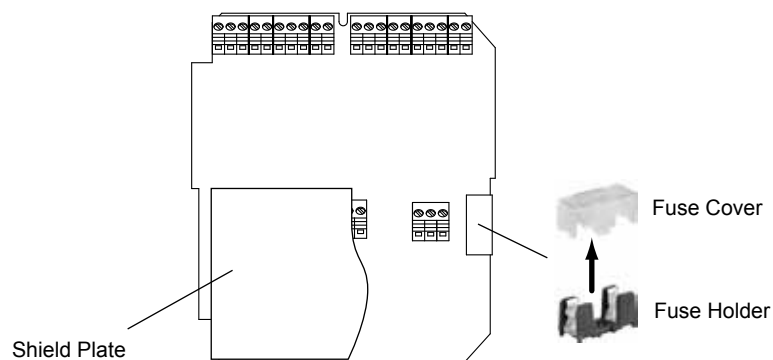


Figure 7-1. How to replace the fuse

8. TROUBLESHOOTING

This chapter describes the countermeasures for failures, classifying the cases into three categories: dissolvedoxygen converter failure, detection of failure with the self-diagnosis function, and abnormal measured values. The causes for abnormal measured values are not limited to equipment failures. if an abnormal phenomenon occurs, first check the following items:

- Is the property of the measuring solution different from normal ?
- Is the dissolvedoxygen sensor properly installed?

8-1. Measures in the case of converter operation failure

8-1-1. No dissolved-oxygen converter operation

If the converter does not operate even when the power is supplied, one cause may be a blown fuse inside the converter.

Examine the fuse by turning off the power supply (see Subsection 3-3-1 on page 3-5).

If the fuse is blown, replace it with a new one. If fuses frequently blow and the cause is not clear, request an inspection by Yokogawa.

If the fuse is normal, examine the wiring system.

8-1-2. Operation key or display failure

If the operation keys do not operate smoothly or the display fails (e.g., a missing character segment), repair of the printed circuit board (digital board) (replacement with a new one) is required.

After the printed circuit board is replaced, operation checks and parameter settings are necessary.

Contact Yokogawa and request board-replacement work.

8-2. Measures in the case of failure (Error) detection

If a failure is detected through the self-diagnosis of the DO402G dissolved oxygen converter, the FAIL contact is closed. The FAIL lamp on the operation panel lights up and an error number appears in the data display.

Note:

If an error is detected during configuration, the FAIL contact signal is output immediately but the error number is displayed after that action or operation is completed.

When a FAIL contact signal is output, take measures according to Table 8-1.

Table 8-1. Countermeasures in the case of failure (Error) detection

Error No.	Generation Mode	Error Content and Causes	Countermeasures
E1	AIR.CAL mode H2O. CAL mode	Stability failure Even after an hour has elapsed, the measured value change does not decrease within the set value of (mg/l) • Sensor temperature changes. • Dissolved-oxygen of the calibration solution changes. • The value of A (mg/l) is not suitable.	Eliminate the causes and press the (NO) key to perform re calibration.
E2	H2O. CAL mode	Zero point error failure The zero point error exceeds the set range • Dirt sticks to the tip of the sensor. • Membrane abnormality. Electrolyte degradation.	Clean the sensor membrane, sensor cap, and recalibrate. If the error is detected again, replace the electrolyte and the membrane, sensor cap.
E3	AIR.CAL mode H2O. CAL mode MAN.CAL mode	Slope failure The slope exceeds the range of 40 to 200 % of the theoretical value. • Dirt sticks to the tip of the sensor. • Membrane abnormality. Electrolyte degradation.	Clean the sensor membrane, sensor cap, and recalibrate. If the error is detected again, replace the electrolyte and the membrane. Check that the connection between sensor and sensor cable is fit, and LED emission of the optical dissolved-oxygen sensor. When error occurred again, replace the sensor cap, sensor cable or sensor itself.
E4	Measuring mode	Sensor membrane failure	Replace membrane Check for wet O-rings in the membrane assembly or wet sealing face. Wipe off wet areas and dry out.
E7	All modes	Measured temperature failure (too high) It exceeds 50.0 °C (122.0 °F). • Measuring solution temperature is high • CODE 10 setting is not correct • Sensor cable wiring failure • Temperature sensor has failed	Examine the temperatures of the measuring solution and sensor and the CODE 10 setting Examine the sensor cable connection status. If the temperature sensor fails (abnormal resistance), replace the sensor.
E8	All modes	Measured temperature failure (too low) It falls below 0 °C (or 32.0 °F). • Measuring solution temperature is low • CODE 10 setting is not correct • Sensor cable wiring failure • Temperature sensor has failed.	Examine the temperatures of the measuring solution and sensor and the CODE 10 setting. Examine the sensor cable connection status. If the temperature sensor fails (abnormal resistance), replace the sensor.
E9	All modes	Input current failure It does not satisfy the following equation: input current < 50 µA for galvanic sensor < 500 nA for polarographic sensor and optical sensor	Examine the setting for CODE 01, 02

Error No.	Generation Mode	Error content and Causes	Countermeasures
E10	All modes	EEPROM writing failure Electronic circuit failure	Turn off the power and then turn it back on and check whether or not the system returns to normal. If the failure occurs again, contact Yokogawa to request repair.
E12	All modes	Abnormal measured value The dissolved-oxygen value (%sat.) exceeds 150 % (or value set in CODE 54)	Examine the setting for CODE 01, 02 10, 12 & 54. Accurately perform calibration.
E15	CODE 12	Temperature error correction failure The difference between the corrected value and the standard value exceeds the range corresponding to $\pm 7.5^{\circ}\text{C}$ ($\pm 13.5^{\circ}\text{F}$). • Temperature entry is not accurate. • Sensor cable failure	Accurately measure the temperature of the measuring solution (dissolved oxygen sensor). Examine whether the sensor cable fails (partial disconnection or degraded insulation) and then correct the temperature error again.
E16	All modes	Call for maintenance-interval time exceeded	Perform maintenance. Reset interval.
E17	RANGE mode	Incorrect span. In the range setting, a value which makes the span less than 1.0 mg/l (or ppm) or 10 % sat. has been set.	Change the maximum or minimum value in the range so that a span more than the permissible value is obtained.
E18	CODE 35 & 36	Table values make no sense.	Reprogram.
E19	At data entry	Configuration failure A value not within the permissible range is entered.	Re-enter a value within the permissible range.
E20	All modes	Instrument initialization failure	Repair is necessary. Contact Yokogawa to request repair.
E21	All modes	EPROM comparison failure	Repair if necessary. Contact Yokogawa to request repair.
E22	All modes	The time-out interval for high or low alarm has elapsed. (if the function is enabled in CODE 47)	Take measures depending on the purpose to use this function. Reset the error with the (NO) key or (YES) key.

NOTE:

It is possible that the error message does not disappear immediately after corrective measures. Then turn power off and the turn it back on and check whether the system returns to normal.

9. SPARE PARTS

See Customer Maintenance Parts List.

10. APPENDIX

Adjustable limits and defaults for settings in Commissioning Level

10-1. Setpoint

Variable	Default	Lower limit	Upper limit
*OX1	19.5 mg/l	0.0 mg/l	50.0 mg/l
		0.0 ppm	50.0 ppm
		0.0 %sat	300 %sat
*OX2	1.0 mg/l	0.0 mg/l	50.0 mg/l
		0.0 ppm	50.0 ppm
		0.0 %sat	300 %sat
*OX3	10.0 mg/l	0.0 mg/l	50.0 mg/l
		0.0 ppm	50.0 ppm
		0.0 %sat	300 %sat
*OX4	10.0 mg/l	0.0 mg/l	50.0 mg/l
		0.0 ppm	50.0 ppm
		0.0 %sat	300 %sat
*Sp.mA2	10.0 mg/l	0.0 mg/l	50.0 mg/l
		0.0 ppm	50.0 ppm
		0.0 %sat	300 %sat
* T1	25.0 °C/77 °F	0.0 °C/32 °F	50 °C/122 °F
* T2	25.0 °C/77 °F	0.0 °C/32 °F	50 °C/122 °F
* T3	25.0 °C/77 °F	0.0 °C/32 °F	50 °C/122 °F
* T4	25.0 °C/77 °F	0.0 °C/32 °F	50 °C/122 °F

10-2. Range

Variable	Default	Lower limit	Upper limit
Range 1: Process	0% = 0.00	0.0 mg/l	50.0 mg/l
	100% = 19.99	0.0 ppm	50.0 ppm
		0.0 %sat	300 %sat
Range 2: Process	0% = 0.00	0.0 mg/l	50.0 mg/l
	100% = 19.99	0.0 ppm	50.0 ppm
		0.0 %sat	300 %sat
Temperature	0% = 0 °C / 32 °F 100% = 50 °C / 122 °F	0.0 °C / 32 °F	50 °C / 122 °F

Note:

The range has a minimum span of: 1.0 mg/l, 1.0 ppm or 10 %sat.
In case of a temperature output 25 °C or 50 °F

10-3. Hold

Variable	Default	Lower limit	Upper limit
mA fix 1	10.00 mA	0 or 4 mA	20 mA
mA fix 2	10.00 mA	0 or 4 mA	20 mA

10-4. Wash

Variable	Default	Lower limit	Upper limit
Interval	6 hours	0.1 hours	36.0 hours
Wash time	0.5 minutes	0.1 minutes	10.0 minutes
Recovery time	0.5 minutes	0.1 minutes	10.0 minutes

10-5. User setting table

FUNCTION		SETTING DEFAULTS		USER SETTINGS		
Parameter specific functions						
01	*S.TYPE	0	Galvanic (7 μA)			
	*I.CELL	0	3.75 μA			
02	*CHECK	0.1.0	Zero Off			
			Slope On			
			Membrane Off			
04	*SAL.TY	0	Off			
Temperature measuring functions						
10	*T.SENS	1	Pt1000			
11	*T.UNIT	0	°C			
12	*T.ADJ		None			
13	*T.MAN	0	Off			
Calibration parameter functions						
20	*ΔT.SEC	60	sec.			
	*Δmg/l	0.05	mg/l			
21	*O.CAL	0	Off			
22	*ZERO	0	μA (nA)			
	*SLOPE	3.75 (50)	μA (nA)			
mA outputs						
30	*mA	1.1	both 4-20mA			
31	*OUTP.F	0.2	DO & Temp.			
	*D/R	0	Reverse (control)			
32	*BURN	0.0	both off			
33	*RG.mA2	5.0 mg/l	only for PI control			
34	*tI.mA2	100 sec	only for PI control			
35	*TABL1	21 pt table	see code 31, §10-1			
36	*TABL2	21 pt table	see code 31, §10-1			
37	*DAMP	0	sec.			
38	*SWTCH	0	Off			
Contacts						
40	*S1	2.0.0	high process AI.			
41	*S2	1.0.0	low process AI.			
42	*S3	4.0.0	WASH			
43	*S4	4.0.0	FAIL			
44	*D.TIME	0.2	sec.			
	*P.HYST	0.1	mg/l			
	*T.HYST	0.5	°C			
45	*RANGE	5.0	mg/l			
	*PER	10.0	sec.			
	*FREQ	70	p/min			
46	*tI.CNT	100 sec.	only for PI control			
47	*EXPIR	0	off			
	*tE.min	15	min			

FUNCTION		SETTING DEFAULTS		USER SETTINGS		
User Interface						
50	*RET	1	on			
51	*MODE	0.0.0	all off			
52	*PASS	0.0.0	all off			
53	*Err.01	1	hard fail			
	*Err.02	1	hard fail			
	*Err.03	1	hard fail			
	*Err.04	1	hard fail			
	*Err.07	1	hard fail			
	*Err.08	1	hard fail			
	*Err.09	1	hard fail			
	*Err.12	1	hard fail			
	*Err.16	0	soft fail			
	*Err.22	0	soft fail			
	*SOFT	0	LCD + fail			
54	*E12	150	%			
55	*CALL.M	0	Off			
56	*UNIT	0	mg/l			
Communication						
60	*COMM.	0.1	off/write prot.			
	*SET.	3.1	9600/odd			
	*ADDR.	00	00			
61	*HOUR					
62	*ERASE					
General						
70	*LOAD					
Test and setup mode						
80	*TEST					

Error codes

Code	Error description	Possible cause	Suggested remedy
E1	Response time failure. Calibration failed to reach stability in 1 hour	Temperature unstable	Avoid draughts and direct sunshine
E2	Zero calibration out of limits Check limits $\pm 0.5 \mu\text{A}$ ($\pm 5.0\text{nA}$)	Zero calibration not properly performed	Repeat carefully
E3	Slope calibration out of limits Check limits 40 to 200 %	Calibration not properly performed Wrong membrane thickness set	Repeat carefully Check code 01
E4	Membrane failure	Perforated membrane	Replace and recalibrate
E7	Temperature too high > 50 °C/122 °F	Process temperature too high Wrong sensor programmed Incorrect wiring	Check process Check model code sensor Check connections and cable
E8	Temperature too low < 0 °C/32 °F	Process temperature too low Wrong sensor programmed Incorrect wiring	Check process Check model code sensor Check connections and cable
E9	Cell current abnormal Galvanic : outside -10 to 50 μA Polarographic: outside -100 to 500 nA	Sensor fault Programming fault	Check membrane Check setup
E10	EEPROM write failure	Fault in electronics	Try again, if unsuccessful contact Yokogawa
E12	Abnormal measured value. The dissolved oxygen value (%sat.) exceeds 150%. (or value set in Code 54)	Wrong DO sensor or temperature sensor programmed. Incorrect wiring.	Check code 01, 02, 10, 12 and 54. Accurately perform calibration.
E15	Cable resistance influence to temperature exceeds $\pm 7.5^\circ\text{C}$ ($\pm 13.5^\circ\text{F}$)	Cable resistance too high Corroded contacts Wrong sensor programmed	Check cable Clean and reterminate Reprogram
E16	Call for maintenance interval time exceeded.	System not maintained in preset time period	Perform maintenance Reset interval
E17	Output span too small	Incorrect configuration by user	Reprogram
E18	Table values make no sense	Wrong data programmed	Reprogram
E19	Programmed values outside acceptable limits	Incorrect configuration by user	Reprogram
E20	All programmed data lost	Fault in electronics Very severe interference	Contact Yokogawa
E21	Checksum error	Software problem	Contact Yokogawa
E22	Alarm activation time exceeded	Process control not effective within set time	Check control equipment Adjust value in code 47

11. APPENDIX 2 QUALITY INSPECTION**Quality
Inspection
Standards****DO402G
Dissolved Oxygen Converter****1. Scope**

This inspection standard applies to the DO402G Dissolved Oxygen Converter.

2. Inspection Items

- 2.1 Insulation resistance test
- *2.2 Dielectric strength test
- 2.3 Current output test
- 2.4 Contact operation test
- 2.5 Temperature indication check
- *2.6 Input current indication check
- 2.7 Atmospheric pressure indication check

Note: Items marked with an asterisk (*) may only be confirmed by a test certificate.

3. Inspection Methods, Standards and Conditions

- Connect the testing circuit as shown in Figure 1. Allow the instrument to warm up for at least 5 minutes before conducting the tests. For the connections for the insulation resistance test, follow the instructions in Sections 3.1 and for the dielectric strength test, follow the instructions in Section 3.2.
- Performance tests should be done in the inspection mode where the tests from Section 3.3 through Section 3.7 take place in sequence and cannot be retraced. If the reconfirmation of a test is needed, turn off the power to the converter, turn on the power again, and enter the inspection mode to restart the tests.

3.1 Insulation Resistance Test

Apply 500 V DC between the power supply terminals shorted together (1 and 2) and the protective earth terminal outside of the case. The insulation resistance must be 100 MΩ or greater.

3.2 Dielectric Strength Test

Apply 1400 V AC, an AC voltage of substantially sinusoidal waveform with a frequency of 50 Hz or 60 Hz, between the power terminals shorted together (1 and 2) and the protective earth terminal outside of the case, for at least 2 seconds. The insulation must withstand this voltage. (The sensed current should be 15 mA.)

3.3 Current Output Test

Use the following procedure to enter the inspection mode.

(1) Entering Service Code 87

- a. Press the [*] key. The message display will show “*SETP.”
- b. Press the [NO] key four times. The message display will show “*SERV.”
- c. Press the [YES] key. The data display will show “00” with the first digit of 0 flashing.
- d. Press the [^] key eight times. The data display will show “80” with the first digit of 8 flashing.
- e. Press the [>] key once. The data display will show “80” with the second digit of 0 flashing.

- f. Press the [$\wedge$] key seven times. The data display will show "87" with the second digit of 7 flashing.
- g. Press the [ENT] key. The message display will show "*PASS*."

(2) Setting Password 070

- a. Press the [>] key once. The data display will show "000" with the second digit of 0 flashing.
- b. Press the [$\wedge$] key seven times. The data display will show "070" with the second digit of 7 flashing.
- c. Press the [ENT] key. The data display will show "HIF."
- d. Press the [YES] key. The message display will show a manufacturing control number.

This is the inspection mode.

Press the [ENT] key until the message display shows "mA1+2."

Each time the [ENT] key is pressed, the value on the data display increases in steps of 4.0, like "0.0," "4.0," "8.0," up to 20.0. Check the current outputs 1 and 2. Corresponding to the data display, the current output must be within the range shown in Table 1.

When the data display shows "12.0," pressing the [ENT] key causes the message display to show "RIPPLE" and the data display to remain unchanged. Press the [ENT] key again. The message display will show "mA" and the data display "16.0."

Table 1

Data Display	Current Output 1 (mA DC)	Current Output 2 (mA DC)
4.0	4 $\pm$ 0.02	4 $\pm$ 0.02
12.0	12 $\pm$ 0.02	12 $\pm$ 0.02
20.0	20 $\pm$ 0.02	20 $\pm$ 0.02

3.4 Contact Operation Test

Following Section 3.3, press the [ENT] key until the message display shows "JUMPER." Then press the [ENT] key once, the message display will show "*WAIT*" and LEDs S1, S2, WASH/S3, and FAIL/S4 flash rapidly. Check that the message display shows and LEDs turns on/off in the order as shown in Table 2 and that a message of "FAIL x" does not appear.

Table 2

Message Display	S1	S2	WASH/S3	FAIL/S4
LED1	OFF	ON	ON	OFF
LED2	ON	OFF	ON	OFF
LED3	ON	ON	OFF	OFF
LED4	ON	ON	ON	ON

3.5 Temperature Indication Check

Following Section 3.4, press the [ENT] key until the message display shows "PT1000." In this state, change the resistance of the decade resistance box as shown in Table 3 and check the data display. The value on the data display must be within the range shown in Table 3.

Table 3

Temperature (°C)	Resistance (Ω)	Data Display (°C)
5	1019.5	5 ± 0.3
25	1097.3	25 ± 0.3
45	1174.7	45 ± 0.3

3.6 Input Current Indication Check

Following Section 3.5, press the [ENT] key until the message display shows "GALVA1." Turn SW1 on. Change the current of the standard current generator and check the data display. The value on the data display must be within the range shown in Table 4.

Table 4

Reference (μ A)	Data Display (μ A)
0	0 ± 0.05
8	8 ± 0.05
16	16 ± 0.05

Press the [ENT] key until the message display shows "GALVA2." Change the current of the standard current generator and check the data display. The value on the data display must be within the range shown in Table 5.

Table 5

Reference (μ A)	Data Display (μ A)
10	10 ± 0.1
30	30 ± 0.2
50	50 ± 0.2

Turn SW1 off. Press the [ENT] key until the message display shows "POLAR1." Change the current of the standard current generator and check the data display. The value on the data display must be within the range shown in Table 6.

Table 6

Reference (nA)	Data Display (nA)
0	0 ± 0.2
80	80 ± 0.2
160	160 ± 0.2

Press the [ENT] key until the message display shows "POLAR2." Change the current of the standard current generator and check the data display. The value on the data display must be within the range shown in Table 7.

Table 7

Reference (nA)	Data Display (nA)
100	100 ± 0.2
300	300 ± 1
500	500 ± 1

3.7 Atmospheric Pressure Indication Check

Following Section 3.6, press the [ENT] key until the message display shows "PRESS."
Check that the data display indication at this time is within the range from 900 (hPa) to 1100 (hPa).

Press the [ENT] key. The message display will show "READY."

Continue to press the [ENT] key to return to normal measurement mode.

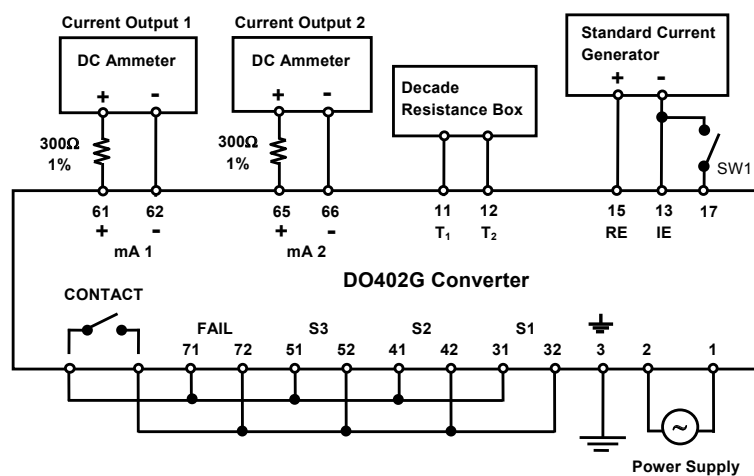


Figure 1 Testing Circuit and Test Equipment

成績表 TEST CERTIFICATE

製品名称 PRODUCT NAME	溶存酸素変換器 DISSOLVED OXYGEN CONVERTER	タグNo. TAG NO.
形名 MODEL	DO402G	
手配No. ORDER NO.		計器番号 SERIAL NO.

検査項目		INSPECTION ITEM		結果 RESULT	
外 観					
APPEARANCE					
絶縁抵抗	電源端子(1,2)一括とケース外の保護接地端子間 100MΩ 以上 / 500V DC				
INSULATION	BETWEEN POWER SUPPLY TERMINALS (1,2) AND PROTECTIVE EARTH TERMINAL				
RESISTANCE	OUTSIDE THE CASE 100MΩ OR MORE / 500V DC				
耐電圧	電源端子(1,2)一括とケース外の保護接地端子間 1400V AC / 2秒間				
DIELECTRIC	BETWEEN POWER SUPPLY TERMINALS (1,2) AND PROTECTIVE EARTH TERMINAL				
STRENGTH	OUTSIDE THE CASE 1400V AC / 2sec				
出力電流	許容差: ±0.02 mA ACCURACY: ±0.02 mA				
CURRENT OUTPUT					
	表示	出力1 OUTPUT1 (mA DC)		出力2 OUTPUT2 (mA DC)	
	INDICATION	基準値 REF.	実測値 ACTUAL	誤差 ERROR	
	4.0	4		4	
	12.0	12		12	
	20.0	20		20	
接点動作	表示 INDICATION: LED1, LED2, LED3, LED4				
OPERATION OF CONTACT	点灯LED LIGHT LED: S1, S2, S3, FAIL/S4				
温度表示	許容差: ±0.3 °C ACCURACY: ±0.3 °C				
TEMPERATURE	PT1000				
INDICATION	抵抗値	表示 INDICATION (°C)			
	(Ω)	基準値	実測値	誤差	
	RESISTANCE	REF.	ACTUAL	ERROR	
	1019.5	5			
	1097.3	25			
	1174.7	45			
入力電流表示	GALVA.1		GALVA.2		
INPUT CURRENT	入力電流	表示 INDICATION (μA)		入力電流	表示 INDICATION (μA)
INDICATION	(μA)	基準値±許容差	実測値	(μA)	基準値±許容差
	INPUT CURRENT	REF.±ACCURACY	ACTUAL	INPUT CURRENT	REF.±ACCURACY
	0	0 ± 0.05		10	10 ± 0.1
	8	8 ± 0.05		30	30 ± 0.2
	16	16 ± 0.05		50	50 ± 0.2
	POLAR.1		POLAR.2		
	入力電流	表示 INDICATION (nA)		入力電流	表示 INDICATION (nA)
	(nA)	基準値±許容差	実測値	(nA)	基準値±許容差
	INPUT CURRENT	REF.±ACCURACY	ACTUAL	INPUT CURRENT	REF.±ACCURACY
	0	0 ± 0.2		100	100 ± 0.2
	80	80 ± 0.2		300	300 ± 1
	160	160 ± 0.2		500	500 ± 1
大気圧表示	900hPa ~ 1100hPa				
ATMOSPHERIC PRESSURE					
INDICATION					

NOTES

日付 DATE	室内温度・湿度 AMBIENT TEMP. & HUM.	°C & %
検査者 INSPECTOR	承認者 APPROVED BY	

YOKOGAWA ◆

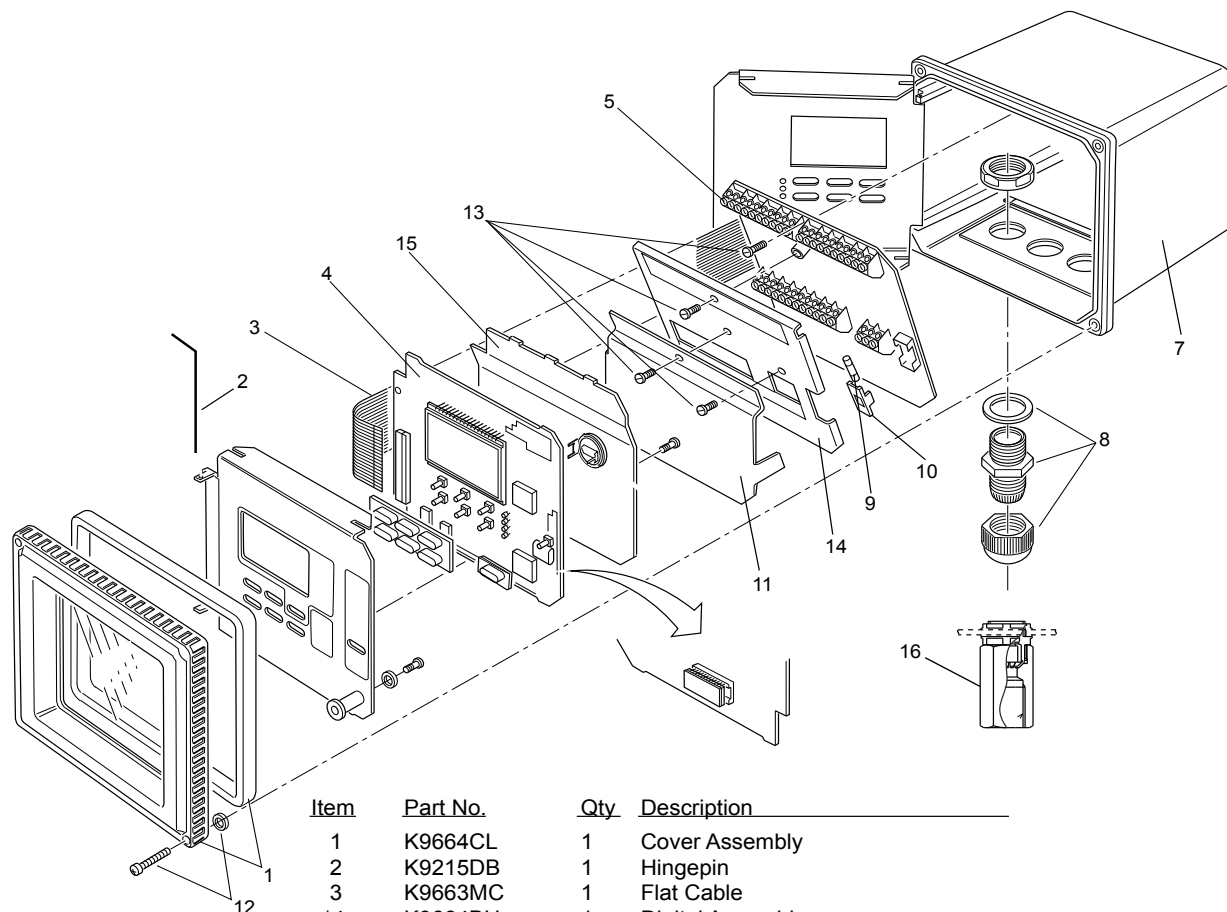
QIC-12J05D02-01

Ed6: Sep. 2013

Customer Maintenance Parts List

Model DO402G [Style: S3]
Dissolved Oxygen Converter

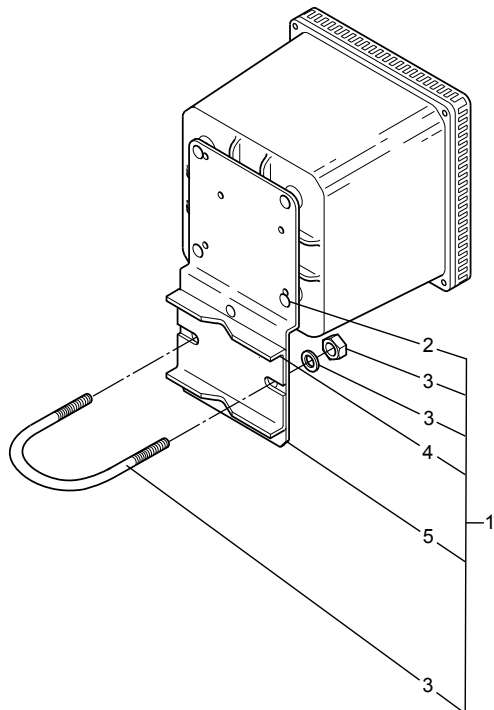
EXA □□



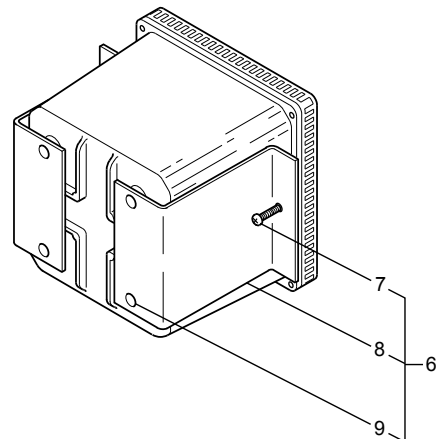
Item	Part No.	Qty	Description
1	K9664CL	1	Cover Assembly
2	K9215DB	1	Hingepin
3	K9663MC	1	Flat Cable
*4	K9664BU	1	Digital Assembly
*5	—	—	Analog Assembly
	K9664HA	1	For 100 V AC
	K9664HB	1	For 115 V AC
	K9664HC	1	For 230 V AC
7	—	—	Housing
	K9672DA	1	Polyurethane baked finish
	K9672DB	1	Epoxy baked finish
8	K9663MM	1	Cable Gland Assembly
9	—	—	Fuse (Time Lag Fuse)
	A1105EF	1	For 100 V AC Power, 0.200 A,T
	A1105EF	1	For 115 V AC Power, 0.200 A,T
	A1103EF	1	For 230 V AC Power, 0.100 A,T
10	A1565EF	1	Fuse Holder
11	K9672BJ	1	Bracket Assembly
12	K9664DH	1	Stainless steel screw assembly to fix cover
13	K9664DK	1	Screw Assembly
14	—	—	Bracket Assembly for Analog Board
	K9664CH	1	For 100 V AC
	K9664CJ	1	For 115 V AC
	K9664CK	1	For 230 V AC
15	K9664AR	1	Bracket Assembly for Digital Board
16	—	—	Adapter Assembly
	K9171SU	1	For G1/2 screw when /AFTG specified.
	K9316AF	1	For 1/2NPT screw when /ANSI specified.

* Do not exchange these parts. Call service personnel.

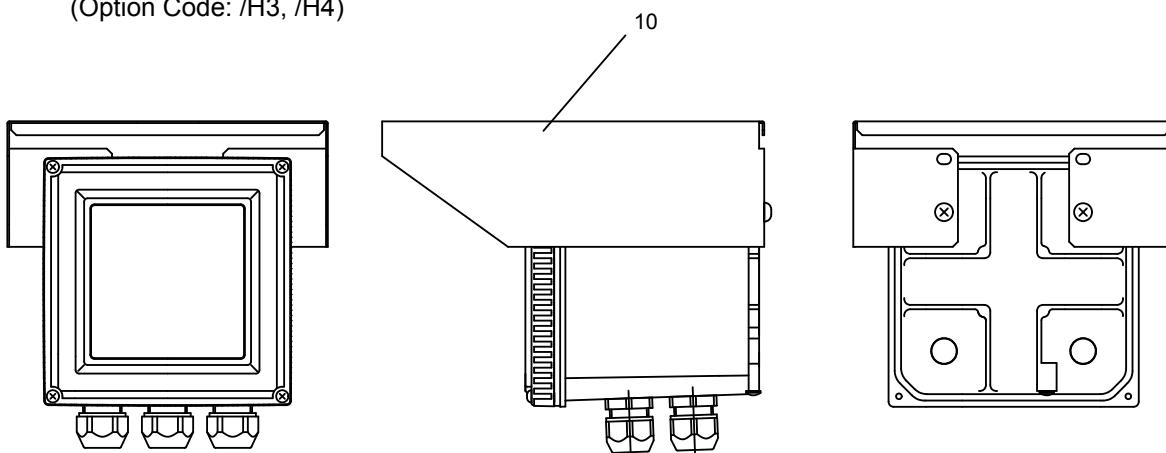
Pipe/Wall Mounting Hardware
(Option Code : /U)



Panel Mounting Hardware
(Option Code : /PM)



Sun Protection Cover
(Option Code: /H3, /H4)



Item	Part No.	Qty	Description
1	K9171SS	1	Mounting Set (/U)
2	Y9608KU	4	Screw
3	D0117XL-A	1	U-Bolt Assembly
4	K9171SY	1	Plate
5	K9171SX	1	Bracket
6	K9171ST	1	Mounting Set (/PM)
7	Y9520LU	2	Screw
8	K9171SW	2	Bracket
9	Y9608KU	4	Screw
10	—		Sun Protection Cover
	K9664CA	1	Carbon steel (/H3)
	K9664CC	1	Stainless steel (/H4)

Revision Record

Manual Title : Model DO402G Dissolved Oxygen Converter [Style: S3]

Manual Number : IM 12J05D02-01E

Edition	Date	Remark (s)
1st	Apr. 2003	Newly published
2nd	Feb. 2004	Style changed to S2
3rd	Sep. 2006	On p.ii, After-sales Warranty modified.; On p.2-3, Operating specifications modified.; On p.3-2, Housing dimensions of Fig. 3.01 modified.; On p.3-4, Fig. 3.04 Wiring Diagram modified.; On p.6-4, Tips for water calibration added.; On p.6-6, Some error corrected.
4th	Mar. 2007	All over revised. (Style of DO402G changed to S3.)
5th	Jul. 2007	Page 2-2: Addition of CSA certified to item. M. Safety and EMC conforming standards; Page 2-3: Some of G. Housing description revised; Page 3-3: Addition of CSA certified to Sec. 3.2 Wiring; Page 3-4: The torque to tighten frontplate screws added.
6th	Oct. 2007	Appendix 2 Quality Inspection added.
7th	Feb. 2012	PREFACE, Addition of "How to dispose the batteries".; Page 2-2, Some revision of M. Safety and EMC conforming standards (description for EMC revised).; Page 4-4, Figure of Section 4-4. "Display functions (default)" modified.; Page 5-16, Explanation of the code 21 modified.; Page 5-25, Some revision of the code 53 (*Err.16 error setting).; Page 6-1, Caution of calibration added to Sec.6.; Page 6-4, Some revision of Sec. 6-3-1, and note for water calibration method of Sec. 6-3-2 modified.; Last page, Added of KC mark.
8th	Feb. 2014	Page 2-2, 2-3, 3-4 Safety standard is revised. Page 3-10 to 3-11 Some revision of section 3-8. Wiring the standard optical sensor (DO70G). Page 5-1 Some revision of section 5-1. Maintenance mode. Page 5-2 Some revision of section 5-1-1. Manual activation of Hold. Page 5-11 Some revision of section 5-2-3. Hold. Page 7-1 Some revision of Table 7-2. Page 8-2 to 8-3 Some revision of Table 8-1. Page Appendix 2 11-1 to 11-5 QIS 12J05D02-01E, QIC-12J05D02-01 revised (some change of dielectric strength test). CMPL 12J05D02-03E revised to 2nd edition (some of P/N changed).

